

# PROJECT MANUAL AND SPECIFICATIONS

## City of Springfield City Complex Springfield, FL



PREPARED BY:

**M**

**M**

MOTT  
MACDONALD

**1022 West 23<sup>rd</sup> Street  
Panama City, FL 32405**

MM Project #502100062

**August 2024**

-PROFESSIONAL SEALS PAGE--

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DESIGN PROFESSIONALS OF RECORD

A. ARCHITECT

Andrew P. Marasca, Mott MacDonald Florida LLC  
1022 West 23<sup>rd</sup> Street, Panama City, FL 32405  
License # AR103481  
Certificate of Authorization # AA-C0000035

10-03-2023

B. STRUCTURAL ENGINEER

Michael J. Tugwell, Mott MacDonald Florida LLC  
1022 West 23<sup>rd</sup> Street, Panama City, FL 32405  
License # 84726  
Certificate of Authorization # 0000155

10-03-2023

C. CIVIL ENGINEER

Amir Zafar, Mott MacDonald Florida LLC  
1022 West 23<sup>rd</sup> Street, Panama City, FL 32405  
License # 56829  
Certificate of Authorization # 0000155

MM Project #  
502100062

City of Springfield  
City Complex

10-03-2023

D. MECHANICAL/FIRE PROTECTION

Gregory D. Peterson, Peterson Engineering, Inc.  
75 South "F" Street, Pensacola, FL 32502  
License # 34088  
Certificate of Authorization (Registry) # 3600

10-03-2023

E. ELECTRICAL ENGINEER

Andrew K. Gibbs, Mott MacDonald Florida LLC  
1022 West 23rd Street, Panama City, FL 32405  
License # 77293  
Certificate of Authorization # 0000155

10-03-2023

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City of Springfield – City Complex  
Springfield, Florida

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***CONDITIONS OF THE CONTRACT***

**ADVERTISEMENT FOR BIDS  
CITY OF SPRINGFIELD, FLORIDA**

The **City of Springfield** is requesting Bids for the construction of the following Project:

**SPRINGFIELD CITY COMPLEX  
Mott MacDonald Project No. 502100062**

In response to destruction of the City of Springfield facilities by Hurricane Michael in October 2018, the City proposes to build a new **Springfield City Complex**, located at 1141 Transmitter Road. The Project includes the following Work:

**Civil Site Work, New City Hall (6,632 sf), New Fire Station (11,191 sf), New Police Station (5,935 sf), and New Public Works Facility (15,565 sf).**

Sealed Bids for the construction of the Project will be received at the **City of Springfield City Hall** located at **408 School Avenue, Springfield, FL 32401**, where Bids will be received until **2:00 pm** local time on **September 10, 2024**. At that time the Bids received will be publicly opened and read. It is the sole responsibility of the Bidder to ensure the bid is received on time.

**The construction of these facilities will be with funding assistance from the Federal Emergency Management Agency (FEMA) and the Department of Housing and Urban Development (HUD). As a result of different compliance and documentation requirements of the funding agencies, the work, if awarded, will be awarded under two separate Contracts and both Contracts awarded to one successful Bidder. The contract requirements for each of the two Contracts are defined within the Bidding Documents.**

The Project has an expected duration of **540 days**.

Envelope(s) containing bids must be sealed and marked **"Sealed Bid for Construction of Springfield City Complex."**

Any bids received after the stipulated time of bid opening will not be accepted and will be returned unopened.

Bids shall be on a Lump Sum basis, with additive alternate bid items as indicated on the Bid Form. The Owner reserves the right to award the contracts, if awarded, based on the base bids and any combination of additive or deductive (if applicable) bid item(s), whichever the Owner determines is in the City's best interest.

The Issuing Office for the Bidding Documents is **Mott MacDonald, 1022 West 23rd Street, Suite 680, Panama City, FL., 32405. (ph. 850-763-9393)**. Prospective Bidders may examine the Bidding Documents at the Issuing Office on Mondays through Fridays between the hours of 8:30 a.m. – 4:00 p.m. and may obtain copies of the Bidding Documents, as described below, from the Issuing Office via emailed request sent to [Beverly.Stephens@mottmac.com](mailto:Beverly.Stephens@mottmac.com).

Electronic format of the Bidding Documents may be obtained by means of a temporary ftp (file transfer protocol) site from the Issuing Office, during the hours indicated above, at a non-refundable cost of \$125.00. The date that the Bidding Documents are transmitted by the Issuing Office will be considered the Bidder's date of receipt of the Bidding Documents. Partial sets of Bidding Documents will not be available from the Issuing Office. Neither Owner nor Engineer will be responsible for full or partial sets of Bidding Documents, including Addenda if any, obtained from sources other than the Issuing Office.

Addenda, if any, will be provided electronically to plan holders and a return receipt will be requested to verify receipt.

**Pre-bid Conference**

A pre-bid conference for the Project will be held on **August 27, at 1:00 pm** at City of Springfield City Hall located at 408 School Avenue, Springfield, FL 32401. A site visit will be held thereafter. Attendance at the pre-bid conference is encouraged but not required.

Bid security shall be furnished in accordance with the Instructions to Bidders.

All bids must be submitted on the Bid Form as furnished in the Specifications document. The bids must be accompanied by a Form 287 Drug Free Workplace, Public Entity Crime Statement, plus other documents required in the Instructions to Bidders, and by a Bid Bond, certified check, or cashier's check in the amount of five percent (5%) of the Base Bid as a guarantee that the bidder will enter into an agreement with the Owner if his bid is accepted.

The bid shall remain in force for sixty (60) days after the time of opening.

Attention of bidders is called to the licensing laws of Florida. All bidders must comply with all applicable State and local laws concerning licensing, registration, and regulation of contractors doing business in the State of Florida. Further, contractors shall obtain all such occupational licenses and permits as shall be prescribed by law.

The Owner reserves the right to reject any or all bids and to waive informalities in any bid whenever such rejection or waiver is in the best interest of the Owner. Additionally, the Owner reserves the right to award the contracts to any bidder.

Bidders shall submit proof of qualifications to perform the Work as described in the Instructions to Bidders.

Respondents are hereby notified that Section 287.05701, Florida Statutes, requires that the City may not request documentation of or consider a vendor's social, political, or ideological interests when determining if the vendor is a responsible vendor.

Advertisement is issued by:

Owner: **City of Springfield**

By:



**Ralph L. Hammond, Mayor**

Date: **08/01/2024**

## PREFACE TO INSTRUCTIONS TO BIDDERS

As publicized in the Advertisement for Bids, the City of Springfield proposes to build a new City Complex (City Hall, Fire Station, Police Station, and Public Works Building) at 1141 Transmitter Road. Also as noted in the Advertisement for Bids, the Civil Site Work, if awarded, will be awarded as a separate contract (Contract #1) from the contract for the buildings (Contract #2).

Contract #1 is for the Civil Site Work on the City Complex site (excluding for the City Hall building) and is funded by a CDBG-DR (Disaster Recovery) grant. The CDBG-DR supplemental conditions for Contract #1 are provided in Attachment A to this Preface (ten pages) which is titled “Contractual Provisions for FEMA & United States Department of Housing & Urban Development (HUD) Projects”. These agency supplemental conditions in Attachment A are specific to the work of Contract #1 and are applicable only to Contract #1. It is important to note that these agency supplemental conditions are in addition to all the requirements outlined in Division 0 Conditions of the Contract(s).

Contract #2 is for the construction of the City Hall, Fire Station, and, subject to selection as additive items, the Police Station and Public Works Building; there are no agency supplemental conditions applicable to Contract #2.

As further documented in the Bid Documents, Contract #1 and Contract #2 will be awarded to one Contractor. Each of the two Contracts will exceed the Simplified Acquisition Threshold therefore simplified acquisition is not applicable.

# ATTACHMENT A to Preface

## CONTRACTUAL PROVISIONS for FEMA & United States Department of Housing & Urban Development (HUD) Projects

### 1. Equal Employment Opportunity.

a The contractor agrees to comply with the requirements of Chapter 760, Florida Statutes, and with Title VI of the Civil Rights Act of 1964 as amended, Title VIII of the Civil Rights Act of 1968 as amended, Section 104(b) and Section 109 of Title I of the Housing and Community Development Act of 1974 as amended, Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, Executive Order 11063, and Executive Order 11246 as amended.

b If this contract is in excess of \$10,000 and meets the definition of a “federally assisted construction contract” as provided in 41 C.F.R. § 60-1.3, the following shall apply to the contractor’s performance under this contract:

- i The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
- ii The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.
- iii The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as part of such employee’s essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action,

including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.

- iv. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- v. The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
- vi. The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
- vii. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions as may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.
- viii. The contractor will include the portion of the sentence immediately preceding paragraph (a) and the provisions of paragraphs (a) through (h) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a

subcontractor or vendor as a result of such direction by the administering agency the contractor may request the United States to enter into such litigation to protect the interests of the United States.

For the purposes of this section, “federally assisted construction contract” means any agreement or modification thereof between any applicant and a person for construction work which is paid for in whole or in part with funds obtained from the Government or borrowed on the credit of the Government pursuant to any Federal program involving a grant, contract, loan, insurance, or guarantee, or undertaken pursuant to any Federal program involving such grant, contract, loan, insurance, or guarantee, or any application or modification thereof approved by the Government for a grant, contract, loan, insurance, or guarantee under which the applicant itself participates in the construction work.

For the purposes of this section, “construction work” means the construction, rehabilitation, alteration, conversion, extension, demolition or repair of buildings, highways, or other changes or improvements to real property, including facilities providing utility services. The term also includes the supervision, inspection, and other onsite functions incidental to the actual construction.

## **2. Davis Bacon Act.**

- a. This section applies to all construction contracts in excess of \$2,000.
- b. In accordance with the requirements of the Davis Bacon Act (40 U.S.C. §§ 3141-3144 and 3146-3148) as supplemented by Department of Labor regulations at 29 C.F.R. Part 5 (Labor Standards Provisions Applicable to Contracts Covering Federally Financed and Assisted Construction), the contractor shall pay wages to laborers and mechanics at a rate not less than the prevailing wages specified in a wage determination made by the Secretary of Labor. In addition, the contractor shall pay wages not less than once a week.
- c. Award of this contract to the contractor is conditioned upon the contractor’s acceptance of the current prevailing wage determination issued by the Department of Labor as provided in the solicitation for this contract.

## **3. Copeland Anti-Kickback Act.**

- a. This section applies to all contracts and subcontracts in excess of \$2,000 for construction or repair.
- b. Contractor. The contractor shall comply with 18 U.S.C. § 874, 40 U.S.C. § 3145, and the requirements of 29 C.F.R. Part 3 as may be applicable, which are incorporated by reference into this contract. Specifically, the contractor is prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he or she is otherwise entitled.

- c Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clause above and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all of these contract clauses.
- d Breach. A breach of the contract clauses above may be grounds for termination of the contract, and for debarment as a contractor and subcontractor as provided in 29 C.F.R. § 5.12.

**4. Contract Work Hours and Safety Standards Act.**

- a This section applies to all contracts in excess of \$100,000 that involve the employment of mechanics or laborers as provided in 40 U.S.C. §3701.
- b As provided in 40 U.S.C. § 3702, and as supplemented by Department of Labor regulations (29 C.F.R. Part 5), the contractor shall compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week.
- c The requirements of 40 U.S.C. § 3704, as supplemented by 29 C.F.R. Part 5, shall apply to construction work and provide that no laborer or mechanic must be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.
- d No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.
- e In the event of any violation of the clause set forth in paragraph (d) of this section the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (d) of this section, in the sum of \$10 for each calendar day on which such



individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (d) of this section.

- f. The County shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (e) of this section.
- g. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (c) through (f) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (c) through (f) of this section.

**5. Compliance With Clean Air Act.**

- a. The contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act, as amended, 42 U.S.C. § 7401 et seq.
- b. The contractor agrees to report each violation to the County and understands and agrees that the County will, in turn, report each violation as required to assure notification to the state of Florida, Federal Emergency Management Agency, and the appropriate Environmental Protection Agency Regional Office.
- c. The contractor agrees to include these requirements in each subcontract exceeding \$100,000 financed in whole or in part with Federal assistance provided through Community Development Block Grant Disaster Recovery funds.

**6. Compliance with Federal Water Pollution Control Act.**

- a. The contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq.
- b. The contractor agrees to report each violation to the County and understands and agrees that the County will, in turn, report each violation as required to assure notification to the state of Florida, Federal Emergency Management Agency, and the appropriate Environmental Protection Agency Regional Office.

- c. The contractor agrees to include these requirements in each subcontract exceeding \$100,000 financed in whole or in part with Federal assistance provided through Community Development Block Grant Disaster Recovery funds.

**7. Debarment and Suspension.**

- a. This contract is a covered transaction for purposes of 2 C.F.R. Part 180 and 2 C.F.R. Part 3000. As such the contractor is required to verify that none of the contractor, its principals (defined at 2 C.F.R. § 180.995), or its affiliates (defined at 2 C.F.R. § 180.905) are excluded (defined at 2 C.F.R. § 180.940) or disqualified (defined at 2 C.F.R. § 180.935).
- b. The contractor must comply with 2 C.F.R. Part 180, Subpart C and 2 C.F.R. Part 3000, Subpart C and must include a requirement to comply with these regulations in any lower tier covered transaction it enters into.
- c. This certification is a material representation of fact relied upon by the County. If it is later determined that the contractor did not comply with 2 C.F.R. Part 180, Subpart C and 2 C.F.R. Part 3000, Subpart C, in addition to remedies available to the state of Florida and the County, the Federal Government may pursue available remedies, including but not limited to suspension and/or debarment.
- d. The bidder or proposer agrees to comply with the requirements of 2 C.F.R. Part 180, Subpart C and 2 C.F.R. Part 3000, Subpart C while this offer is valid and throughout the period of any contract that may arise from this offer. The bidder or proposer further agrees to include a provision requiring such compliance in its lower tier covered transactions.

**8. Byrd Anti-Lobbying Amendment**

Contractors who apply or bid for an award of \$100,000 or more shall file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 U.S.C. § 1352. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient.

**APPENDIX A, 44 C.F.R. PART 18: CERTIFICATION REGARDING LOBBYING**

Certification for Contracts, Grants, Loans, and Cooperative Agreements (To be submitted with each bid or offer exceeding \$100,000)

The undersigned [Contractor] certifies, to the best of his or her knowledge, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form- LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. § 1352 (as amended by the Lobbying Disclosure Act of 1995). Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

The Contractor, \_\_\_\_\_, certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the Contractor understands and agrees that the provisions of 31 U.S.C. § 3801 et seq., apply to this certification and disclosure, if any.

Signature of Contractor's Authorized Official

Name and Title of Contractor's Authorized Official

Date

**9. Procurement of Recovered Materials.**

a In the performance of this contract, the contractor shall comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Recovery Act. The contractor shall make maximum use of products containing recovered materials that are EPA- designated items, as set forth in 40 C.F.R. Part 247, Subpart B, unless the product cannot be acquired—

- i Competitively within a timeframe providing for compliance with the contract performance schedule;
- ii Meeting contract performance requirements; or
- iii At a reasonable price.

b The requirements of this section apply to the purchase or acquisition of any procurement item where the purchase price of the item exceeds \$10,000 or where the quantity of such item or of any functionally equivalent item purchased or acquired in the course of the previous fiscal year is \$10,000 or more.

**10. Section 3 Clause.**

a The work to be performed under this agreement is a project assisted under a program providing direct federal financial assistance from the U.S. Department of Housing and Urban Development (HUD) and is subject to the requirements of Section 3 of the Housing and Urban Development Act of 1968, as amended (12 U.S.C. 1701). Section 3 requires that to the greatest extent feasible, opportunities for training and employment be given to low- and very low-income residents of the project area, and that contracts for work in connection with the project be awarded to business concerns that provide economic opportunities to low- and very low-income persons residing in the metropolitan area in which the project is located.

b The parties to this agreement agree to comply with the requirements of 24 C.F.R. Part 135, which implement Section 3. As evidenced by their execution of this agreement, the parties certify that they are under no impediment what would prevent them from complying with these requirements.

c The contractor agrees to send to each labor organization or representative of workers with which the contractor has a collective bargaining agreement or other understanding, if any, a notice advertising the contractor's commitments under this Section 3 clause. The contractor shall post copies of this notice in conspicuous places at the worksite where both employees and applicants for training and employment positions can see the notice. The notice shall describe the Section 3 preference, shall set forth the minimum number and job titles subject to hire, the availability of apprenticeship and training positions, the qualifications for each, the name and location of the person(s) taking applications for each position, and the anticipated date the work shall begin.

d The contractor agrees to include this Section 3 clause in every subcontract subject to compliance with the regulations set forth in 24 C.F.R. Part 135 and agrees to take appropriate action,

as provided in the applicable provision of the subcontract, or in this Section 3 clause, upon finding that the subcontractor is in violation of the regulations set forth in 24 C.F.R. Part 135. The contractor shall not subcontract with any subcontractor where the contractor has notice or knowledge that the subcontractor has been found in violation of the regulations in 24 C.F.R. Part 135.

e. The contractor will certify that any vacant employment positions, including training positions, that are filled (1) after the contractor is selected but before the contract is executed, and (2) with persons other than those to whom the regulations of 24 C.F.R. part 135 require employment opportunities to be directed, were not filled to circumvent the contractor's obligations under 24 C.F.R. part 135.

f. Noncompliance with the regulations set forth in 24 C.F.R. part 135 may result in sanctions, termination of this agreement for default, and debarment or suspension from future HUD-assisted contracts.

g. With respect to work performed in connection with Section 3-covered Indian housing assistance, Section 7(b) of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450e) also applies to the work to be performed under this agreement. Section 7(6) requires that to the greatest extent feasible, (i) preference and opportunities for training and employment shall be given to Indians, and (ii) preference in the award of contracts and subcontracts shall be given to Indian organizations and Indian-owned Economic Enterprises. Parties to this agreement that are subject to the provisions of Section 3 and Section 7(b) agree to comply with Section 3 to the maximum extent feasible, but not in derogation of compliance with Section 7(b).

## **11. Compliance with Federal Law, Regulations, and Executive Orders.**

This is an acknowledgement that this contract is funded entirely or in part by FEMA Financial Assistance and Community Development Block Grant Disaster Recovery funds. The contractor will comply with all applicable federal law, regulations, executive orders, FEMA and Department of Housing and Urban Development policies, procedures, and directives, including, but not limited to:

- a. The Housing and Community Development Act of 1974, as amended;
- b. Section 312 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. § 5155), as amended;
- c. Section 18 of the Small Business Act (14A U.S.C. § 647), as amended;
- d. 44 C.F.R. § 206.191 (Duplication of Benefit), as amended;
- e. Federal Register, Vol. 76, No. 221, November 16, 2011 (76 FR 71060): Clarification of Duplication of Benefits Requirements Under the Stafford Act for Community Development Block Grant (CDBG) Disaster Recovery Grantees;

- f Public Law 114-223: Continuing Appropriations Act, 2017;
- g Public Law 114-254: Further Continuing and Security Assistance Appropriations Act, 2017;
- h HUD Federal Register Notice published at 81 FR 83254 dated November 21, 2016;
- i HUD Federal Register Notice published at 82 FR 5591 dated January 18, 2017; and
- j HUD Federal Register Notice published at 82 FR 36812 dated August 7, 2017.

**12. No Obligation by Federal Government.**

The Federal Government is not a party to this contract and is not subject to any obligations or liabilities to the non-Federal entity, contractor, or any other party pertaining to any matter resulting from the contract.

**13. Fraud and False or Fraudulent or Related Acts.**

The contractor acknowledges that 31 U.S.C. Chap. 38 (Administrative Remedies for False Claims and Statements) applies to the contractor's actions pertaining to this contract.

"General Decision Number: FL20240105 04/26/2024

Superseded General Decision Number: FL20230105

State: Florida

Construction Type: Heavy

County: Bay County in Florida.

HEAVY CONSTRUCTION PROJECTS (Including Sewer and Water Lines)

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least \$17.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2024.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least \$12.90 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2024.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <http://www.dol.gov/whd/govcontracts>.

Modification Number	Publication Date
0	01/05/2024
1	04/26/2024

\* ENGI0653-012 10/01/2023

	Rates	Fringes
POWER EQUIPMENT OPERATOR: Cranes 100 Tons & Over (Conventional & Hydraulic) & Tower Cranes.....	\$ 31.25	14.55
Cranes Under 100 Tons.....	\$ 30.25	14.55
Oiler.....	\$ 28.95	14.55

Cranes with 350 feet or more boom and/or 400 ton capacity -  
additional \$1.10 per hour.

Cranes with 500 feet boom and/or 600 ton capacity -  
additional \$1.45 per hour.

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IRON0798-008 07/01/2023

	Rates	Fringes
IRONWORKER, STRUCTURAL.....	\$ 29.00	17.52

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PAIN0164-006 06/01/2021

	Rates	Fringes
PAINTER: Brush, Roller and Spray.....	\$ 20.21	12.38

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\* SUFL2009-144 06/24/2009

	Rates	Fringes
CARPENTER.....	\$ 15.36 **	0.00
CEMENT MASON/CONCRETE FINISHER...	\$ 14.77 **	3.50
ELECTRICIAN.....	\$ 17.25	3.02
LABORER: Common or General.....	\$ 9.13 **	1.02
LABORER: Landscape.....	\$ 7.25 **	0.00
LABORER: Pipelayer.....	\$ 11.51 **	2.94
LABORER: Power Tool Operator (Hand Held Drills/Saws, Jackhammer and Power Saws Only).....	\$ 10.63 **	2.20
OPERATOR: Asphalt Paver.....	\$ 11.59 **	0.00
OPERATOR: Backhoe Loader Combo.....	\$ 16.10 **	2.44
OPERATOR: Backhoe/Excavator.....	\$ 13.11 **	1.51
OPERATOR: Bulldozer.....	\$ 15.00 **	4.98
OPERATOR: Grader/Blade.....	\$ 16.00 **	2.84
OPERATOR: Loader.....	\$ 13.89 **	2.07



OPERATOR: Mechanic.....	\$ 14.32 **	0.00
OPERATOR: Roller.....	\$ 10.76 **	0.00
OPERATOR: Scraper.....	\$ 11.00 **	1.74
OPERATOR: Trackhoe.....	\$ 20.92	5.50
OPERATOR: Tractor.....	\$ 10.54 **	0.00
TRUCK DRIVER, Includes Dump Truck.....	\$ 8.52 **	0.25
TRUCK DRIVER: Lowboy Truck.....	\$ 12.73 **	0.00
TRUCK DRIVER: Off the Road Truck.....	\$ 12.21 **	1.97

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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 \*\* Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$17.20) or 13658 (\$12.90). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

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The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical

order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

#### Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

#### Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

#### Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

#### State Adopted Rate Identifiers

Classifications listed under the ""SA"" identifier indicate that

the prevailing wage rate set by a state (or local) government was adopted under 29 C.F.R. 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 01/03/2024 reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

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WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- \* an existing published wage determination
- \* a survey underlying a wage determination
- \* a Wage and Hour Division letter setting forth a position on a wage determination matter
- \* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations  
Wage and Hour Division  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

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# INSTRUCTIONS TO BIDDERS FOR CONSTRUCTION CONTRACTS

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**ARTICLE 1—DEFINED TERMS**

- 1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:
- A. *Issuing Office*—The office from which the Bidding Documents are to be issued, and which registers plan holders.

**ARTICLE 2—BIDDING DOCUMENTS**

- 2.01 Bidder shall obtain a complete set of Bidding Requirements and proposed Contract Documents (together, the Bidding Documents). See the Agreement for a list of the Contract Documents. It is Bidder's responsibility to determine that it is using a complete set of documents in the preparation of a Bid. Bidder assumes sole responsibility for errors or misinterpretations resulting from the use of incomplete documents, by Bidder itself or by its prospective Subcontractors and Suppliers.
- 2.02 Bidding Documents are made available for the sole purpose of obtaining Bids for completion of the Project and permission to download or distribution of the Bidding Documents does not confer a license or grant permission or authorization for any other use. Authorization to download documents, or other distribution, includes the right for plan holders to print documents solely for their use, and the use of their prospective Subcontractors and Suppliers, provided the plan holder pays all costs associated with printing or reproduction. Printed documents may not be re-sold under any circumstances.
- 2.03 Bidder may register as a plan holder and obtain complete sets of Bidding Documents, in the number and format stated in the Advertisement or invitation to bid, from the Issuing Office. Bidders may rely that sets of Bidding Documents obtained from the Issuing Office are complete, unless an omission is blatant. Registered plan holders will receive Addenda issued by Owner.
- 2.04 *Electronic Documents*
- A. When the Bidding Requirements indicate that electronic (digital) copies of the Bidding Documents are available, such documents will be made available to the Bidders as Electronic Documents in the manner specified.
1. Bidding Documents will be provided in Adobe PDF (Portable Document Format) (.pdf). It is the intent of the Engineer and Owner that such Electronic Documents are to be exactly representative of the paper copies of the documents. However, because the Owner and Engineer cannot totally control the transmission and receipt of Electronic Documents nor the Contractor's means of reproduction of such documents, the Owner and Engineer cannot and do not guarantee that Electronic Documents and reproductions prepared from those versions are identical in every manner to the paper copies.
- B. Unless otherwise stated in the Bidding Documents, the Bidder may use and rely upon complete sets of Electronic Documents of the Bidding Documents, described in Paragraph 2.04.A above. However, Bidder assumes all risks associated with differences arising from transmission/receipt of Electronic Documents versions of Bidding Documents and reproductions prepared from those versions and, further, assumes all risks, costs, and

responsibility associated with use of the Electronic Documents versions to derive information that is not explicitly contained in printed paper versions of the documents, and for Bidder's reliance upon such derived information.

### **ARTICLE 3—QUALIFICATIONS OF BIDDERS**

- 3.01 To demonstrate Bidder's qualifications to perform the Work, Bidder shall submit with its Bid the following information:
- A. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.
  - B. A written statement that Bidder is authorized to do business in the state where the Project is located.
  - C. Bidder's state or other contractor license number, if applicable.
- 3.02 A Bidder's failure to submit required qualification information within the times indicated may disqualify Bidder from receiving an award of the Contracts.
- 3.03 No requirement in this Article 3 to submit information will prejudice the right of Owner to seek additional pertinent information regarding Bidder's qualifications.

### **ARTICLE 4—PRE-BID CONFERENCE**

- 4.01 A non-mandatory pre-bid conference will be held at the time and location indicated in the Advertisement or invitation to bid. Representatives of Owner and Engineer will be present to discuss the Project. Bidders are encouraged to attend and participate in the conference; however, attendance at this conference is not required to submit a Bid.
- 4.02 Information presented at the pre-Bid conference does not alter the Contract Documents. Owner will issue Addenda to make any changes to the Contract Documents that result from discussions at the pre-Bid conference. Information presented, and statements made at the pre-bid conference will not be binding or legally effective unless incorporated in an Addendum.

### **ARTICLE 5—SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE**

- 5.01 *Site and Other Areas*
- A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.
- 5.02 *Existing Site Conditions*
- A. *Subsurface and Physical Conditions; Hazardous Environmental Conditions*
    - 1. The Supplementary Conditions identify the following regarding existing conditions at or adjacent to the Site:

## Instruction to Bidders

- a. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data.
  - b. Those drawings known to Owner of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data.
  - c. Reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.
  - d. Technical Data contained in such reports and drawings.
2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.
  3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.
  4. *Geotechnical Baseline Report/Geotechnical Data Report*: The Bidding Documents may contain a Geotechnical Baseline Report (GBR) and/or a Geotechnical Data Report (GDR).  
(*Note: If no Geotechnical Report(s) are contained in the bidding document, none were generated for this project*)
    - a. As set forth in the Supplementary Conditions, the GBR describes certain select subsurface conditions that are anticipated to be encountered by Contractor during construction in specified locations (“Baseline Conditions”). The GBR is a Contract Document.
    - b. The Baseline Conditions in the GBR are intended to reduce uncertainty and the degree of contingency in submitted Bids. However, Bidders cannot rely solely on the Baseline Conditions. Bids should be based on a comprehensive approach that includes an independent review and analysis of the GBR, all other Contract Documents, Technical Data, other available information, and observable surface conditions. Not all potential subsurface conditions are baselined.
    - c. Nothing in the GBR is intended to relieve Bidders of the responsibility to make their own determinations regarding construction costs, bidding strategies, and Bid prices, nor of the responsibility to select and be responsible for the means, methods, techniques, sequences, and procedures of construction, and for safety precautions and programs incident thereto.
    - d. As set forth in the Supplementary Conditions, the GDR is a Contract Document containing data prepared by or for the Owner in support of the GBR.
- B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05 of the General Conditions, and not in the drawings referred to in



## Instruction to Bidders

Paragraph 5.02.A of these Instructions to Bidders. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

**5.03 Other Site-related Documents**

- A. No other Site-related documents are available.

**5.04 Site Visit and Testing by Bidders**

- A. Bidder is required to visit the Site and conduct a thorough visual examination of the Site and adjacent areas. During the visit the Bidder must not disturb any ongoing operations at the Site.
- B. A Site visit is scheduled following the pre-bid conference. Maps to the Site will be available at the pre-Bid conference.
- C. Bidders visiting the Site are required to arrange their own transportation to the Site.
- D. All access to the Site other than during a regularly scheduled Site visit must be coordinated through the Owner for visiting the Site. Bidder must conduct the required Site visit during normal working hours.
- E. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder general access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site. Bidder is responsible for establishing access needed to reach specific selected test sites.
- F. Bidder must comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.
- G. Bidder must fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

**5.05 Owner's Safety Program**

- A. Site visits and work at the Site may be governed by an Owner safety program. If an Owner safety program exists, it will be noted in the Supplementary Conditions.

**5.06 Other Work at the Site**

- A. Reference is made to Article 8 of the Supplementary Conditions for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

**ARTICLE 6—BIDDER’S REPRESENTATIONS AND CERTIFICATIONS****6.01** *Express Representations and Certifications in Bid Form, Agreement*

- A. The Bid Form that each Bidder will submit contains express representations regarding the Bidder’s examination of Project documentation, Site visit, and preparation of the Bid, and certifications regarding lack of collusion or fraud in connection with the Bid. Bidder should review these representations and certifications, and assure that Bidder can make the representations and certifications in good faith, before executing and submitting its Bid.
- B. If Bidder is awarded the Contracts, Bidder (as Contractor) will make similar express representations and certifications when it executes the Agreement.

**6.02** *It is the responsibility of each Bidder before submitting a Bid to:*

- A. examine and carefully study the Bidding Documents, and any data and reference items identified in the Bidding Documents;
- B. visit the Site, conduct a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfy itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;
- C. become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work;
- D. carefully study all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings;
- E. consider the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and (3) Bidder’s safety precautions and programs;
- F. agree, based on the information and observations referred to in the preceding paragraph, that at the time of submitting its Bid no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the

## Instruction to Bidders

- Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents;
- G. become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;
  - H. promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder;
  - I. determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work; and
  - J. agree that the submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

**ARTICLE 7—INTERPRETATIONS AND ADDENDA**

- 7.01 Owner on its own initiative may issue Addenda to clarify, correct, supplement, or change the Bidding Documents.
- 7.02 Bidder shall submit all questions about the meaning or intent of the Bidding Documents to Engineer in writing via the contact shown below.
  - A. **Tommy Pitts, Project Manager** [tommy.pitts@mottmac.com](mailto:tommy.pitts@mottmac.com)
- 7.03 Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all registered plan holders. Questions received less than seven days prior to the date for opening of Bids may not be answered.
- 7.04 Only responses set forth in an Addendum will be binding. Oral and other interpretations or clarifications will be without legal effect. Responses to questions are not part of the Contract Documents unless set forth in an Addendum that expressly modifies or supplements the Contract Documents.

**ARTICLE 8—BID SECURITY**

- 8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of five (5%) percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a Bid bond issued by a surety meeting the requirements of Paragraph 6.01 of the General Conditions. Such Bid bond will be issued in the form included in the Bidding Documents.
- 8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contracts to such Bidder, and such Bidder has executed the Contracts, furnished the required Contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract and furnish the required Contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited, in whole in the case of a penal sum bid bond, and to the extent of Owner's

## Instruction to Bidders

damages in the case of a damages-form bond. Such forfeiture will be Owner's exclusive remedy if Bidder defaults.

- 8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of 7 days after the Effective Date of the Contracts or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.
- 8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within 7 days after the Bid opening.

**ARTICLE 9—CONTRACT TIMES**

- 9.01 The number of days within which, or the dates by which, the Work is to be (a) substantially completed and (b) ready for final payment, and (c) Milestones (if any) are to be achieved, are set forth in the Agreement.
- 9.02 Provisions for liquidated damages, if any, for failure to timely attain a Milestone, Substantial Completion, or completion of the Work in readiness for final payment, are set forth in the Agreement.

**ARTICLE 10—SUBSTITUTE AND “OR EQUAL” ITEMS**

- 10.01 The Contracts for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, and those “or-equal” or substitute or materials and equipment subsequently approved by Engineer prior to the submittal of Bids and identified by Addendum. No item of material or equipment will be considered by Engineer as an “or-equal” or substitute unless written request for approval has been submitted by Bidder and has been received by Engineer within 15 days of the issuance of the Advertisement for Bids or invitation to Bidders. Each such request must comply with the requirements of Paragraphs 7.05 and 7.06 of the General Conditions, and the review of the request will be governed by the principles in those paragraphs. The burden of proof of the merit of the proposed item is upon Bidder. Engineer's decision of approval or disapproval of a proposed item will be final. If Engineer approves any such proposed item, such approval will be set forth in an Addendum issued to all registered Bidders. Bidders cannot rely upon approvals made in any other manner.
- 10.02 All prices that Bidder sets forth in its Bid will be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding Documents, as supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of “or-equal” or substitution requests are made at Bidder's sole risk.

**ARTICLE 11—SUBCONTRACTORS, SUPPLIERS, AND OTHERS**

- 11.01 The apparent Successful Bidder, and any other Bidder so requested, must submit to Owner a list of the Subcontractors or Suppliers proposed for certain portions of the Work within five days after Bid opening. Examples of Items for which this may be required is as follows:
- A. Subcontractors: All
  - B. All Equipment: Pumps, Controls, Mixers, Electrical Gear, etc.

## Instruction to Bidders

- 11.02 If requested by Owner, such list must be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor or Supplier. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor or Supplier, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, in which case apparent Successful Bidder will submit a substitute, Bidder's Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and Owner may consider such price adjustment in evaluating Bids and making the Contract award.
- 11.03 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contracts to the next lowest Bidder that proposes to use acceptable Subcontractors and Suppliers. Declining to make requested substitutions will constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor or Supplier, so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.07 of the General Conditions.
- 11.04 The Contractor shall not award work to subcontractor(s) in excess of the limits stated in SC 7.07.

**ARTICLE 12—PREPARATION OF BID**

- 12.01 The Bid Form is included with the Bidding Documents.
- A. All blanks on the Bid Form must be completed in ink and the Bid Form signed in ink. Erasures or alterations must be initialed in ink by the person signing the Bid Form. A Bid price must be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.
- B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words "No Bid" or "Not Applicable."
- 12.02 If Bidder has obtained the Bidding Documents as Electronic Documents, then Bidder shall prepare its Bid on a paper copy of the Bid Form printed from the Electronic Documents version of the Bidding Documents. The printed copy of the Bid Form must be clearly legible, printed on 8½ inch by 11-inch paper and as closely identical in appearance to the Electronic Document version of the Bid Form as may be practical. The Owner reserves the right to accept Bid Forms which nominally vary in appearance from the original paper version of the Bid Form, providing that all required information and submittals are included with the Bid.
- 12.03 A Bid by a corporation must be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation must be shown.
- 12.04 A Bid by a partnership must be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership must be shown.
- 12.05 A Bid by a limited liability company must be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm must be shown.

- 12.06 A Bid by an individual must show the Bidder's name and official address.
- 12.07 A Bid by a joint venture must be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The joint venture must have been formally established prior to submittal of a Bid, and the official address of the joint venture must be shown.
- 12.08 All names must be printed in ink below the signatures.
- 12.09 The Bid must contain an acknowledgment of receipt of all Addenda, the numbers of which must be filled in on the Bid Form.
- 12.10 Postal and e-mail addresses and telephone number for communications regarding the Bid must be shown.
- 12.11 The Bid must contain evidence of Bidder's authority to do business in the state where the Project is located, or Bidder must certify in writing that it will obtain such authority within the time for acceptance of Bids and attach such certification to the Bid.
- 12.12 If Bidder is required to be licensed to submit a Bid or perform the Work in the state where the Project is located, the Bid must contain evidence of Bidder's licensure, or Bidder must certify in writing that it will obtain such licensure within the time for acceptance of Bids and attach such certification to the Bid. Bidder's state contractor license number, if any, must also be shown on the Bid Form.

#### **ARTICLE 13—BASIS OF BID**

##### **13.01 *Lump Sum***

- A. Bidders must submit a Bid on a lump sum basis as set forth in the Bid Form.

##### **13.02 *Base Bid with Alternates (if Applicable)***

- A. Bidders must submit a Bid on a lump sum basis for the base Bid and include a separate price for each alternate described in the Bidding Documents and as provided for in the Bid Form. The price for each alternate will be the amount added to or deleted from the base Bid if Owner selects the alternate.
- B. In the comparison of Bids, alternates will be applied in the same order of priority as listed in the Bid Form.

##### **13.03 *Unit Price***

- A. Bidders must submit a Bid on a unit price basis for each item of Work listed in the unit price section of the Bid Form.
- B. The "Bid Price" (sometimes referred to as the extended price) for each unit price Bid item will be the product of the "Estimated Quantity", which Owner or its representative has set forth in the Bid Form, for the item and the corresponding "Bid Unit Price" offered by the Bidder. The total of all unit price Bid items will be the sum of these "Bid Prices"; such total will be used by Owner for Bid comparison purposes. The final quantities and Contract Prices will be determined in accordance with Paragraph 13.03 of the General Conditions.

## Instruction to Bidders

- C. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

**13.04 Allowances**

- A. For cash allowances the Bid price must include such amounts as the Bidder deems proper for Contractor's overhead, costs, profit, and other expenses on account of cash allowances, if any, named in the Contract Documents, in accordance with Paragraph 13.02.B of the General Conditions.

**ARTICLE 14—SUBMITTAL OF BID**

- 14.01 The Bidding Documents include one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 2 of the Bid Form.
- 14.02 A Bid must be received no later than the date and time prescribed and at the place indicated in the Advertisement or invitation to bid and must be enclosed in a plainly marked package with the Project title, and, if applicable, the designated portion of the Project for which the Bid is submitted, the name and address of Bidder, and must be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid must be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED." A mailed Bid must be addressed to the location designated in the Advertisement.
- 14.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted and will be returned to the Bidder unopened.

**ARTICLE 15—MODIFICATION AND WITHDRAWAL OF BID**

- 15.01 An unopened Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.
- 15.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 15.01 and submit a new Bid prior to the date and time for the opening of Bids.
- 15.03 If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, the Bidder may withdraw its Bid,

and the Bid security will be returned. Thereafter, if the Work is rebid, the Bidder will be disqualified from further bidding on the Work.

#### **ARTICLE 16—OPENING OF BIDS**

16.01 Bids will be opened at the time and place indicated in the advertisement or invitation to bid and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

#### **ARTICLE 17—BIDS TO REMAIN SUBJECT TO ACCEPTANCE**

17.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

#### **ARTICLE 18—EVALUATION OF BIDS AND AWARD OF CONTRACT**

18.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner also reserves the right to waive all minor Bid informalities not involving price, time, or changes in the Work.

18.02 Owner will reject the Bid(s) of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible.

18.03 If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, whether in the Bid itself or in a separate communication to Owner or Engineer, then Owner will reject the Bid as nonresponsive.

18.04 If Owner awards the contracts for the Work, such award will be to the responsible Bidder submitting the lowest responsive Bid.

18.05 The portion of the Work covered by Contract #1 and the portion of the Work Covered by Contract #2, if awarded, will both be awarded to one Contractor. On the Bid Proposal Form, the "Sum of Contract #1 Plus Contract #2" (including the bid amount of any Additive Items accepted by Owner) will be the amount considered when determining the lowest responsive Bid.

18.06 Bidders wishing to bid on the City Complex must submit bids for each of its components, Items No. 1 through 5 (refer to the first column on the Bid Proposal Form), including: Item No. 1 – Contract #1 – Civil Site Work; Item No. 2 – City Hall Building; Item No. 3 – Fire Station Building; Item No. 4 – Additive Item #1 Police Station Building; and Item No. 5 – Additive Item #2 Public Works Building.

18.07 *Evaluation of Bids*

A. In evaluating Bids, Owner will consider whether the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.



## Instruction to Bidders

- B. For determination of the apparent low Bidder(s) when sectional bids are submitted, Bids will be compared on the basis of the aggregate of the Bids for separate sections and the Bids for combined sections that result in the lowest total amount for all of the Work.
  - C. For the determination of the apparent low Bidder when unit price bids are submitted, Bids will be compared on the basis of the total of the products of the estimated quantity of each item and unit price Bid for that item, together with any lump sum items.
- 18.08 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.
- 18.09 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

**ARTICLE 19—BONDS AND INSURANCE**

- 19.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds, other required bonds (if any), and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it must be accompanied by required bonds and insurance documentation.
- 19.02 Article 8, Bid Security, of these Instructions, addresses any requirements for providing bid bonds as part of the bidding process.

**ARTICLE 20—SIGNING OF AGREEMENT**

- 20.01 When Owner issues a Notice of Award to the Successful Bidder, it will be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder must execute and deliver the required number of counterparts of the Agreement and any bonds and insurance documentation required to be delivered by the Contract Documents to Owner. Within 10 days thereafter, Owner will deliver one fully executed counterpart of the Agreement to Successful

## Instruction to Bidders

Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

**ARTICLE 21—SALES AND USE TAXES**

21.01 Owner is exempt from Florida state sales and use taxes on materials and equipment to be incorporated in the Work, Exemption No. 576002787. Said taxes must not be included in the Bid. Refer to Paragraph SC-7.10 of the Supplementary Conditions for additional information.

**ARTICLE 22—DAVIS-BACON WAGE REQUIREMENTS**

22.01 As described in detail elsewhere within these Specifications, the Work of this project is divided into two Contracts based upon the source of funding for each Contract. Work funded by Federal CDBG funds must comply with Davis-Bacon Wage Requirements, as follows.

A. Contract #1 Civil Site Work for the City Complex is funded by CDBG DR (Disaster Recovery) funds and the wage rates for Contract #1 must comply with Davis-Bacon Wage Determination Decision Number FL20230105 dated 01/20/2023 which is included elsewhere in these Specifications.

B. Contract #2 for the construction of the City Hall, Fire Station, and, if selected, Police and Public Works Buildings are NOT required to comply with Davis-Bacon.

## BID FORM FOR CONSTRUCTION CONTRACT

The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

### ARTICLE 1—OWNER AND BIDDER

- 1.01 This Bid is submitted to: City of Springfield (Owner)
- 1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

### ARTICLE 2—ATTACHMENTS TO THIS BID

- 2.01 The following documents are submitted with and made a condition of this Bid:
- A. Required Bid security;
  - B. List of Proposed Subcontractors (if applicable);
  - C. List of Proposed Suppliers (if applicable);
  - D. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such authority within the time for acceptance of Bids;
  - E. Contractor's license number \_\_\_\_\_;
  - F. Required Bidder Qualification Statement with supporting data; and
  - G. Form 287 Statement under section 287.087 Florida Statutes, on Preference to Businesses with Drug-Free Workplace Programs
  - H. Sworn Statement under Section 287.133(3)(A) Florida Statutes on Public Entity Crimes
  - I. Certificate of Compliance with Florida Trench Safety Act

### ARTICLE 3—BASIS OF BID—LUMP SUM BID AND UNIT PRICES

- 3.01 Unit Price Bids or Lump Sum Bids
- A. Bidder will perform the Work at the indicated unit prices or lump sum bid as shown in **Attachment A: Proposal Bid Form**
  - B. Bidder acknowledges that:
    - 1. each Bid Unit Price includes an amount considered by Bidder to be adequate to cover Contractor's overhead and profit for each separately identified item, and
    - 2. estimated quantities are not guaranteed and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Work will be based on actual quantities, determined as provided in the Contract Documents.

**ARTICLE 4—TIME OF COMPLETION**

- 4.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.
- 4.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

**ARTICLE 5—BIDDER’S ACKNOWLEDGEMENTS: ACCEPTANCE PERIOD, INSTRUCTIONS, AND RECEIPT OF ADDENDA**

- 5.01 *Bid Acceptance Period*
  - A. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.
- 5.02 *Instructions to Bidders*
  - A. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security.
- 5.03 *Receipt of Addenda*
  - A. Bidder hereby acknowledges receipt of the following Addenda:

<b>Addendum Number</b>	<b>Addendum Date</b>

**ARTICLE 6—BIDDER’S REPRESENTATIONS AND CERTIFICATIONS**

- 6.01 *Bidder’s Representations*
  - A. In submitting this Bid, Bidder represents the following:
    - 1. Bidder has examined and carefully studied the Bidding Documents, including Addenda.
    - 2. Bidder has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
    - 3. Bidder is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
    - 4. Bidder has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.

5. Bidder has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, if selected as Contractor; and (c) Bidder's (Contractor's) safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Bidder agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
8. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
9. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. The submission of this Bid constitutes an incontrovertible representation by Bidder that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

6.02 *Bidder's Certifications*

A. The Bidder certifies the following:

1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation.
2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
3. Bidder has not solicited or induced any individual or entity to refrain from bidding.
4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 8.02.A:
  - a. Corrupt practice means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process.
  - b. Fraudulent practice means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at

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EJCDC® C-410, Bid Form for Construction Contract.

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artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition.

- c. Collusive practice means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels.
- d. Coercive practice means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

BIDDER hereby submits this Bid as set forth above:

Bidder:

\_\_\_\_\_  
*(typed or printed name of organization)*

By:

\_\_\_\_\_  
*(individual's signature)*

Name:

\_\_\_\_\_  
*(typed or printed)*

Title:

\_\_\_\_\_  
*(typed or printed)*

Date:

\_\_\_\_\_  
*(typed or printed)*

*If Bidder is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.*

Attest:

\_\_\_\_\_  
*(individual's signature)*

Name:

\_\_\_\_\_  
*(typed or printed)*

Title:

\_\_\_\_\_  
*(typed or printed)*

Date:

\_\_\_\_\_  
*(typed or printed)*

Address for giving notices:

\_\_\_\_\_  
\_\_\_\_\_

Bidder's Contact:

Name:

\_\_\_\_\_  
*(typed or printed)*

Title:

\_\_\_\_\_  
*(typed or printed)*

Phone:

\_\_\_\_\_

Email:

\_\_\_\_\_

Address:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Bidder's Contractor License No.: (if applicable) \_\_\_\_\_

# BID PROPOSAL FORM

## CITY OF SPRINGFIELD

### CITY COMPLEX

BIDDER agrees to perform all the work described in the CONTRACT DOCUMENTS for the following lump sums:

ITEM NO.*	DESCRIPTION	UNITS	TOTAL COST
<b>CONTRACT #1</b>			
1*	<p><b><u>Civil Site Work - City Complex</u></b></p> <p>NOTE: Excluded from this Contract #1 is any civil site work, utilities, or any other improvements for the new City Hall. The civil site work for the new City Hall building is to be included In Item No. 2 below, "City Hall"</p> <p style="text-align: right;"><b>BID FOR CONTRACT #1 TOTAL</b></p>	LS	\$ _____
<b>CONTRACT #2</b>			
2*	<p><b><u>City Hall</u></b></p> <p>NOTE: Includes the City Hall building and all civil site work, utilities, and any other improvements for the City Hall building.</p>	LS	\$ _____
3*	<b><u>Police Station</u></b>	LS	\$ _____
4*	<b><u>Fire Station</u></b>	LS	\$ _____
5*	<b><u>Public Works Building</u></b>	LS	\$ _____
<b>BID FOR CONTRACT #2 TOTAL</b>			\$ _____
<b>TOTAL BID (SUM OF CONTRACTS #1 &amp; #2)</b>			\$ _____

\* For a detailed description of each Bid Item, see **Specifications Section 012200 "UNIT PRICES - MEASUREMENT AND PAYMENT," PART 2, BID ITEMS.**)



**UNIT PRICES**

The Following unit prices shall include all labor, materials and necessary incidentals required to install referenced items, in the event these items are added or deleted from the contract scope of work.

ITEM NO.	SPEC. REF.	DESCRIPTION	UNITS		UNIT COST
1	012200	6" PVC WATER PIPE	LF		\$ _____
2	012200	6" GATE VALVE	EA		\$ _____
3	012200	GLAND	EA		\$ _____
4	012200	FIRE HYDRANT ASSEMBLY	EA		\$ _____
5	012200	D.I. FITTINGS	LBS		\$ _____
6	012200	LATERALS	LF		\$ _____
7	012200	CONCRETE	CY		\$ _____
8	425-1	INLET	EA		\$ _____
9	425-2	4' DIA. STORM DRAIN MANHOLE	EA		\$ _____
10	430-1	15" RCP CL. III	LF		\$ _____
11	430-1	18" RCP CL. III	LF		\$ _____
12	430-1	24" RCP CL. III	LF		\$ _____

**BID BOND (PENAL SUM FORM)**

<p><b>Bidder</b> Name: <b>[Full formal name of Bidder]</b> Address <i>(principal place of business)</i>: <b>[Address of Bidder's principal place of business]</b></p>	<p><b>Surety</b> Name: <b>[Full formal name of Surety]</b> Address <i>(principal place of business)</i>: <b>[Address of Surety's principal place of business]</b></p>
<p><b>Owner City of Springfield</b> Name: <b>City of Springfield</b> Address <i>(principal place of business)</i>: <b>408 School Avenue Springfield, FL 32401</b></p>	<p><b>Bid</b> Project <i>(name and location)</i>: <b>Springfield City Complex 1141 Transmitter Road, Springfield, FL 32401</b>  Bid Due Date: <b>[Enter date bid is due]</b></p>
<p><b>Bond</b> Penal Sum: <b>[Amount]</b> Date of Bond: <b>[Date]</b></p>	
<p>Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth in this Bid Bond, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.</p>	
<p>Bidder</p>	<p>Surety</p>
<p style="text-align: center;"><i>(Full formal name of Bidder)</i></p>	<p style="text-align: center;"><i>(Full formal name of Surety) (corporate seal)</i></p>
<p>By: _____ <i>(Signature)</i></p>	<p>By: _____ <i>(Signature) (Attach Power of Attorney)</i></p>
<p>Name: _____ <i>(Printed or typed)</i></p>	<p>Name: _____ <i>(Printed or typed)</i></p>
<p>Title: _____</p>	<p>Title: _____</p>
<p>Attest: _____ <i>(Signature)</i></p>	<p>Attest: _____ <i>(Signature)</i></p>
<p>Name: _____ <i>(Printed or typed)</i></p>	<p>Name: _____ <i>(Printed or typed)</i></p>
<p>Title: _____</p>	<p>Title: _____</p>
<p><i>Notes: (1) Note: Addresses are to be used for giving any required notice. (2) Provide execution by any additional parties, such as joint venturers, if necessary.</i></p>	

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond will be Owner's sole and exclusive remedy upon default of Bidder.
2. Default of Bidder occurs upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation will be null and void if:
  - 3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
  - 3.2. All Bids are rejected by Owner, or
  - 3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).
4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions does not in the aggregate exceed 120 days from the Bid due date without Surety's written consent.
6. No suit or action will be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety, and in no case later than one year after the Bid due date.
7. Any suit or action under this Bond will be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder must be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Postal Service registered or certified mail, return receipt requested, postage pre-paid, and will be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond will be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute governs and the remainder of this Bond that is not in conflict therewith continues in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

STATEMENT UNDER SECTION 287.087  
FLORIDA STATUTES, ON PREFERENCE TO BUSINESSES WITH  
DRUG-FREE WORKPLACE PROGRAMS

287.087: Preference to businesses with drug-free workplace programs.

IDENTICAL TIE BIDS: Whenever two or more BIDS which are equal with respect to price, quality, and service are received by the OWNER for this project, a bid received from a business that certifies that it has implemented a drug-free workplace program shall be given preference in the award process. In order to have a drug-free workplace program, a business shall:

1. Publish a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the workplace and specifying the actions that will be taken against employees for violations of such prohibition.
2. Inform employees about the dangers of drug abuse in the workplace, the business's policy of maintaining a drug-free workplace, any available drug counseling, rehabilitation, and employee assistance programs, and the penalties that may be imposed upon employees for drug abuse violations.
3. Give each employee engaged in providing the commodities or contractual services that are under bid a copy of the statement specified in subsection (1).
4. In the statement specified in subsection (1), notify the employees that, as a condition of working on the commodities or contractual services that are under bid, the employee will abide by the terms of the statement and will notify the employer of any conviction of, or plea of guilty or nolo contendere to, any violation of chapter 893 or of any controlled substance law of the United States or any state, for a violation occurring in the workplace no later than 5 days after such conviction.
5. Impose a sanction on, or require the satisfactory participation in a drug abuse assistance or rehabilitation program if such is available in the employee's community by, any employee who is so convicted.
6. Make a good faith effort to continue to maintain a drug-free workplace through implementation of this section.

As the person authorized to sign this statement, I certify that this firm complies fully with the above requirements.

\_\_\_\_\_  
BIDDER'S SIGNATURE

SWORN STATEMENT UNDER SECTION 287.133(3)(A)  
FLORIDA STATUTES ON PUBLIC ENTITY CRIMES

**This form must be signed and sworn to in the presence of a Notary Public or other officer authorized to administer oaths.**

**287.133 Public entity crime; denial or revocation of the right to transact business with public entities.—**

(1) As used in this section:

(a) “Affiliate” means:

1. A predecessor or successor of a person convicted of a public entity crime; or
2. An entity under the control of any natural person who is active in the management of the entity and who has been convicted of a public entity crime. The term “affiliate” includes those officers, directors, executives, partners, shareholders, employees, members, and agents who are active in the management of an affiliate. The ownership by one person of shares constituting a controlling interest in another person, or a pooling of equipment or income among persons when not for fair market value under an arm’s length agreement, shall be a prima facie case that one person controls another person. A person who knowingly enters into a joint venture with a person who has been convicted of a public entity crime in Florida during the preceding 36 months shall be considered an affiliate.

(b) “Convicted” or “conviction” means a finding of guilt or a conviction of a public entity crime, with or without an adjudication of guilt, in any federal or state trial court of record relating to charges brought by indictment or information after July 1, 1989, as a result of a jury verdict, nonjury trial, or entry of a plea of guilty or nolo contendere.

(c) “Convicted vendor list” means the list required to be kept by the department pursuant to paragraph (3)(d).

(d) “Department” means the Department of Management Services.

(e) “Person” means any natural person or any entity organized under the laws of any state or of the United States with the legal power to enter into a binding contract and which bids or applies to bid on contracts let by a public entity, or which otherwise transacts or applies to transact business with a public entity. The term “person” includes those officers, directors, executives, partners, shareholders, employees, members, and agents who are active in management of an entity.

(f) “Public entity” means the State of Florida, any of its departments or agencies, or any political subdivision.

(g) “Public entity crime” means a violation of any state or federal law by a person with respect to and directly related to the transaction of business with any public entity or with an agency or political subdivision of any other state or with the United States, including, but not limited to, any bid, proposal, reply, or contract for goods or services, any lease for real property, or any contract for the construction or repair of a public building or public work, involving antitrust, fraud, theft, bribery, collusion, racketeering, conspiracy, or material misrepresentation.

SWORN STATEMENT UNDER SECTION 287.133(3)(A)  
FLORIDA STATUTES ON PUBLIC ENTITY CRIMES

(2)(a) A person or affiliate who has been placed on the convicted vendor list following a conviction for a public entity crime may not submit a bid, proposal, or reply on a contract to provide any goods or services to a public entity; may not submit a bid, proposal, or reply on a contract with a public entity for the construction or repair of a public building or public work; may not submit bids, proposals, or replies on leases of real property to a public entity; may not be awarded or perform work as a contractor, supplier, subcontractor, or consultant under a contract with any public entity; and may not transact business with any public entity in excess of the threshold amount provided in s. [287.017](#) for CATEGORY TWO for a period of 36 months following the date of being placed on the convicted vendor list.

(b) A public entity may not accept any bid, proposal, or reply from, award any contract to, or transact any business in excess of the threshold amount provided in s. [287.017](#) for CATEGORY TWO with any person or affiliate on the convicted vendor list for a period of 36 months following the date that person or affiliate was placed on the convicted vendor list unless that person or affiliate has been removed from the list pursuant to paragraph (3)(f). A public entity that was transacting business with a person at the time of the commission of a public entity crime resulting in that person being placed on the convicted vendor list may not accept any bid, proposal, or reply from, award any contract to, or transact any business with any other person who is under the same, or substantially the same, control as the person whose name appears on the convicted vendor list so long as that person's name appears on the convicted vendor list.

(3)(a) All invitations to bid, requests for proposals, and invitations to negotiate, as defined in s. [287.012](#), and any contract document described by s. [287.058](#) shall contain a statement informing persons of the provisions of paragraph (2)(a).

(b) Any person must notify the department within 30 days after a conviction of a public entity crime applicable to that person or to an affiliate of that person. Any public entity which receives information that a person has been convicted of a public entity crime shall transmit that information to the department in writing within 10 days.

(c) If the department has reason to believe that a person or an affiliate has been convicted of a public entity crime, the department may issue a written demand upon that person or affiliate, concerning any such conviction or affiliation, to appear and be examined under oath, to answer interrogatories under oath, or to produce documents or other tangible evidence for inspection and copying. The department shall conduct any such inquiry in accord with applicable provisions of the Florida Rules of Civil Procedure.

(d) The department shall maintain a list of the names and addresses of those who have been disqualified from the public contracting and purchasing process under this section. The department shall publish an initial list on January 1, 1990, and shall publish an updated version of the list quarterly thereafter. The revised quarterly lists shall be electronically posted. Notwithstanding this paragraph, a person or affiliate disqualified from the public contracting and purchasing process pursuant to this section shall be disqualified as of the date the final order is entered.

SWORN STATEMENT UNDER SECTION 287.133(3)(A)  
FLORIDA STATUTES ON PUBLIC ENTITY CRIMES

(e)1. Upon receiving reasonable information from any source that a person has been convicted, the department shall investigate the information and determine whether good cause exists to place that person or an affiliate of that person on the convicted vendor list. If good cause exists, the department shall notify the person or affiliate in writing of its intent to place the name of that person or affiliate on the convicted vendor list, and of the person's or affiliate's right to a hearing, the procedure that must be followed, and the applicable time requirements. If the person or affiliate does not request a hearing, the department shall enter a final order placing the name of the person or affiliate on the convicted vendor list. No person or affiliate may be placed on the convicted vendor list without receiving an individual notice of intent from the department.

2. Within 21 days of receipt of the notice of intent, the person or affiliate may file a petition for a formal hearing pursuant to ss. [120.569](#) and [120.57\(1\)](#) to determine whether it is in the public interest for that person or affiliate to be placed on the convicted vendor list. A person or affiliate may not file a petition for an informal hearing under s. [120.57\(2\)](#). The procedures of chapter 120 shall apply to any formal hearing under this section except where they are in conflict with the following provisions:

a. The petition shall be filed with the department. The department shall be a party to the proceeding for all purposes.

b. Within 5 days after the filing of the petition, the department shall notify the Division of Administrative Hearings of the request for a formal hearing. The director of the Division of Administrative Hearings shall, within 5 days after receipt of notice from the department, assign an administrative law judge to preside over the proceeding. The administrative law judge, upon request by a party, may consolidate related proceedings.

c. The administrative law judge shall conduct the formal hearing within 30 days after being assigned, unless otherwise stipulated by the parties.

d. Within 30 days after the formal hearing or receipt of the hearing transcript, whichever is later, the administrative law judge shall enter a final order, which shall consist of findings of fact, conclusions of law, interpretation of agency rules, and any other information required by law or rule to be contained in the final order. Such final order shall place or not place the person or affiliate on the convicted vendor list.

e. The final order of the administrative law judge shall be final agency action for purposes of s. [120.68](#).

f. At any time after the filing of the petition, informal disposition may be made pursuant to s. [120.57\(4\)](#). In that event, the administrative law judge shall enter a final order adopting the stipulation, agreed settlement, or consent order.

3. In determining whether it is in the public interest to place a person or affiliate on the convicted vendor list, the administrative law judge shall consider the following factors:

a. Whether the person or affiliate committed a public entity crime.

b. The nature and details of the public entity crime.

SWORN STATEMENT UNDER SECTION 287.133(3)(A)  
FLORIDA STATUTES ON PUBLIC ENTITY CRIMES

- c. The degree of culpability of the person or affiliate proposed to be placed on the convicted vendor list.
  - d. Prompt or voluntary payment of any damages or penalty as a result of the conviction.
  - e. Cooperation with state or federal investigation or prosecution of any public entity crime, provided that a good faith exercise of any constitutional, statutory, or other right during any portion of the investigation or prosecution of any public entity crime shall not be considered a lack of cooperation.
  - f. Disassociation from any other persons or affiliates convicted of the public entity crime.
  - g. Prior or future self-policing by the person or affiliate to prevent public entity crimes.
  - h. Reinstatement or clemency in any jurisdiction in relation to the public entity crime at issue in the proceeding.
  - i. Compliance by the person or affiliate with the notification provisions of paragraph (b).
  - j. The needs of public entities for additional competition in the procurement of goods and services in their respective markets.
  - k. Mitigation based upon any demonstration of good citizenship by the person or affiliate.
4. In any proceeding under this section, the department shall be required to prove that it is in the public interest for the person to whom it has given notice under this section to be placed on the convicted vendor list. Proof of a conviction of the person or that one is an affiliate of such person shall constitute a prima facie case that it is in the public interest for the person or affiliate to whom the department has given notice to be put on the convicted vendor list. Prompt payment of damages or posting of a bond, cooperation with investigation, and termination of the employment or other relationship with the employee or other natural person responsible for the public entity crime shall create a rebuttable presumption that it is not in the public interest to place a person or affiliate on the convicted vendor list. Status as an affiliate must be proven by clear and convincing evidence. If the administrative law judge determines that the person was not convicted or is not an affiliate of such person, that person or affiliate shall not be placed on the convicted vendor list.
5. Any person or affiliate who has been notified by the department of its intent to place his or her name on the convicted vendor list may offer evidence on any relevant issue. An affidavit alone shall not constitute competent substantial evidence that the person has not been convicted or is not an affiliate of a person so convicted. Upon establishment of a prima facie case that it is in the public interest for the person or affiliate to whom the department has given notice to be put on the convicted vendor list, that person or affiliate may prove by a preponderance of the evidence that it would not be in the public interest to put him or her on the convicted vendor list, based upon evidence addressing the factors in subparagraph 3.
- (f)1. A person on the convicted vendor list may petition for removal from the list no sooner than 6 months from the date a final order is entered disqualifying that person from the public purchasing and contracting process pursuant to this section, but may petition for removal at any time if the petition is based upon a reversal of the conviction on appellate review or pardon. The petition shall be filed with the



SWORN STATEMENT UNDER SECTION 287.133(3)(A)  
FLORIDA STATUTES ON PUBLIC ENTITY CRIMES

department, and the proceeding shall be conducted pursuant to the procedures and requirements of this subsection.

2. A person may be removed from the convicted vendor list subject to such terms and conditions as may be prescribed by the administrative law judge upon a determination that removal is in the public interest. In determining whether removal would be in the public interest, the administrative law judge shall give consideration to any relevant factors, including, but not limited to, the factors identified in subparagraph (e)3. Upon proof that a person's conviction has been reversed on appellate review or that he or she has been pardoned, the administrative law judge shall determine that removal of the person or an affiliate of that person from the convicted vendor list is in the public interest.

3. If a petition for removal is denied, the person or affiliate may not petition for another hearing on removal for a period of 9 months after the date of denial, unless the petition is based upon a reversal of the conviction on appellate review or a pardon. The department may petition for removal prior to the expiration of such period if, in its discretion, it determines that removal would be in the public interest.

(4) The conviction of a person for a public entity crime, or placement on the convicted vendor list, shall not affect any rights or obligations under any contract, franchise, or other binding agreement which predates such conviction or placement on the convicted vendor list. However, the administrative law judge in a proceeding instituted under this section may declare voidable any specific contract, franchise, or other binding agreement entered into after July 1, 1989, by a person placed on the convicted vendor list and a public entity, but only if the administrative law judge finds as fact that the person to be placed on the list has not satisfied the criteria set forth in sub-subparagraphs (3)(e)3.d., f., and g.

(5) The provisions of this section do not apply to any activities regulated by the Florida Public Service Commission or to the purchase of goods or services made by any public entity from the Department of Corrections, from the nonprofit corporation organized under chapter 946, or from any accredited nonprofit workshop certified under ss. [413.032-413.037](#)

SWORN STATEMENT UNDER SECTION 287.133(3)(A)  
FLORIDA STATUTES ON PUBLIC ENTITY CRIMES

This form must be signed and sworn to in the presence of a Notary Public or other officer authorized to administer oaths.

STATE OF \_\_\_\_\_

COUNTY OF \_\_\_\_\_

Before me, the undersigned authority, personally appeared \_\_\_\_\_, who, being by me first duly sworn, made the following statement:

1. Name of bidder or contractor: \_\_\_\_\_
2. Address of bidder or contractor: \_\_\_\_\_  
\_\_\_\_\_
3. My relationship to \_\_\_\_\_ is  
(name of bidder or contractor)  
\_\_\_\_\_  
(relationship such as sole proprietor, partner, president, vice president)
4. Neither the entity submitting this sworn statement, nor any officers, directors, executives, partners, shareholders, employees, members, or agents who are active in the management of the entity, nor any affiliate of the entity has been charged with and convicted of a public entity crime subsequent to July 1, 1989.

**(Draw a line through Paragraph 4 if Paragraph 5 below applies)**

5. There has been a conviction of a public entity crime by the bidder or contractor, or an officer, director, executive, partner, shareholder, employee, member or agent of the bidder or contractor or an affiliate of the bidder or contractor. A determination has been made pursuant to Section 287.133(3) by order of the Division of Administrative Hearings that it is not in the public interest for the name of the convicted person or affiliate to appear on the convicted vendor list. The name of the convicted person or affiliate is \_\_\_\_\_. A copy of the order of the Division of Administrative Hearings is attached to this statement.

**(Draw a line through Paragraph 5 if Paragraph 4 above applies)**

Sworn to and subscribed before me in the State and County first mentioned above on \_\_\_\_ day of \_\_\_\_\_, 20\_\_.

Personally known to me \_\_\_\_\_ OR produced identification \_\_\_\_\_  
(type of identification)

\_\_\_\_\_  
Signature of Notary

Notary Public – State of \_\_\_\_\_ (seal)

My commission expires \_\_\_\_\_  
(Print, typed or stamped name of Notary)

**CERTIFICATE OF COMPLIANCE  
WITH FLORIDA TRENCH SAFETY ACT**

Respondent acknowledges that he is solely responsible for complying with the Florida Trench Safety Act (ACT) and Occupational Safety and Health Administrations excavation safety standard 29 CFR 1926.650 (Subpart P as amended). If there is a conflict between the ACT and any local trenching and excavation safety program, the more stringent requirement would apply. Respondent further acknowledges that included in the various items of the proposal are costs for complying with the Florida Trench Safety Act (90-96, Laws of Florida) effective October 1, 1990 and the Occupational Safety and Health Administrations excavation safety standard.

\_\_\_\_\_  
Respondent Name

\_\_\_\_\_  
Authorized Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Printed Name & Title

**ARTICLE 1—GENERAL INFORMATION**

1.01 Provide contact information for the Business:

Legal Name of Business:			
Corporate Office			
Name:		Phone number:	
Title:		Email address:	
Business address of corporate office:			
Local Office			
Name:		Phone number:	
Title:		Email address:	
Business address of local office:			

1.02 Provide information on the Business’s organizational structure:

Form of Business:	<input type="checkbox"/> Sole Proprietorship <input type="checkbox"/> Partnership <input type="checkbox"/> Corporation		
<input type="checkbox"/> Limited Liability Company <input type="checkbox"/> Joint Venture comprised of the following companies:			
	1.		
	2.		
	3.		
Provide a separate Qualification Statement for each Joint Venturer.			
Date Business was formed:		State in which Business was formed:	
Is this Business authorized to operate in the Project location?		<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Pending	

1.03 Identify all businesses that own Business in whole or in part (25% or greater), or that are wholly or partly (25% or greater) owned by Business:

Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			

1.04 Provide information regarding the Business’s officers, partners, and limits of authority.

Name:		Title:	
Authorized to sign contracts:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Limit of Authority:	\$
Name:		Title:	
Authorized to sign contracts:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Limit of Authority:	\$
Name:		Title:	
Authorized to sign contracts:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Limit of Authority:	\$
Name:		Title:	

**ARTICLE 2—LICENSING**

2.01 Provide information regarding licensure for Business:

Name of License:			
Licensing Agency:			
License No:		Expiration Date:	
Name of License:			
Licensing Agency:			
License No:		Expiration Date:	

**ARTICLE 3—DIVERSE BUSINESS CERTIFICATIONS**

3.01 Provide information regarding Business’s Diverse Business Certification, if any. Provide evidence of current certification.

Certification	Certifying Agency	Certification Date
<input type="checkbox"/> Disadvantaged Business Enterprise		
<input type="checkbox"/> Minority Business Enterprise		
<input type="checkbox"/> Woman-Owned Business Enterprise		
<input type="checkbox"/> Small Business Enterprise		
<input type="checkbox"/> Disabled Business Enterprise		
<input type="checkbox"/> Veteran-Owned Business Enterprise		
<input type="checkbox"/> Service-Disabled Veteran-Owned Business		
<input type="checkbox"/> HUBZone Business (Historically Underutilized) Business		
<input type="checkbox"/> Other		
<input type="checkbox"/> None		

**ARTICLE 4—SAFETY**

4.01 Provide information regarding Business’s safety organization and safety performance.

Name of Business’s Safety Officer:		
Safety Certifications		
Certification Name	Issuing Agency	Expiration

4.02 Provide Worker’s Compensation Insurance Experience Modification Rate (EMR), Total Recordable Frequency Rate (TRFR) for incidents, and Total Number of Recorded Manhours (MH) for the last 3 years and the EMR, TRFR, and MH history for the last 3 years of any proposed Subcontractor(s) that will provide Work valued at 10% or more of the Contract Price. Provide documentation of the EMR history for Business and Subcontractor(s).

Year									
Company	EMR	TRFR	MH	EMR	TRFR	MH	EMR	TRFR	MH

**ARTICLE 5—FINANCIAL**

5.01 Provide information regarding the Business’s financial stability. Provide the most recent audited financial statement, and if such audited financial statement is not current, also provide the most current financial statement.

Financial Institution:		
Business address:		
Date of Business’s most recent financial statement:		<input type="checkbox"/> Attached
Date of Business’s most recent audited financial statement:		<input type="checkbox"/> Attached
Financial indicators from the most recent financial statement		
Contractor’s Current Ratio (Current Assets ÷ Current Liabilities)		
Contractor’s Quick Ratio ((Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) ÷ Current Liabilities)		

**ARTICLE 6—SURETY INFORMATION**

6.01 Provide information regarding the surety company that will issue required bonds on behalf of the Business, including but not limited to performance and payment bonds.

Surety Name:			
Surety is a corporation organized and existing under the laws of the state of:			
Is surety authorized to provide surety bonds in the Project location?	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Is surety listed in “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” published in Department Circular 570 (as amended) by the Bureau of the Fiscal Service, U.S. Department of the Treasury? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

**ARTICLE 7—INSURANCE**

7.01 Provide information regarding Business’s insurance company(s), including but not limited to its Commercial General Liability carrier. Provide information for each provider.

Name of insurance provider, and type of policy (CLE, auto, etc.):			
Insurance Provider		Type of Policy (Coverage Provided)	
Are providers licensed or authorized to issue policies in the Project location?			<input type="checkbox"/> Yes <input type="checkbox"/> No
Does provider have an A.M. Best Rating of A-VII or better?			<input type="checkbox"/> Yes <input type="checkbox"/> No
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

**ARTICLE 8—CONSTRUCTION EXPERIENCE**

8.01 Provide information that will identify the overall size and capacity of the Business.

Average number of current full-time employees:	
Estimate of revenue for the current year:	
Estimate of revenue for the previous year:	

8.02 Provide information regarding the Business’s previous contracting experience.

Years of experience with projects like the proposed project:		
As a general contractor:		As a joint venturer:
Has Business, or a predecessor in interest, or an affiliate identified in Paragraph 1.03:		
Been disqualified as a bidder by any local, state, or federal agency within the last 5 years? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Been barred from contracting by any local, state, or federal agency within the last 5 years? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Been released from a bid in the past 5 years? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Defaulted on a project or failed to complete any contract awarded to it? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Refused to construct or refused to provide materials defined in the contract documents or in a change order? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Been a party to any currently pending litigation or arbitration? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Provide full details in a separate attachment if the response to any of these questions is Yes.		

8.03 List all projects currently under contract in Schedule A and provide indicated information.

8.04 List a minimum of three and a maximum of six projects completed in the last 5 years in Schedule B and provide indicated information to demonstrate the Business’s experience with projects similar in type and cost of construction.

8.05 In Schedule C, provide information on key individuals whom Business intends to assign to the Project. Provide resumes for those individuals included in Schedule C. Key individuals include the Project Manager, Project Superintendent, Quality Manager, and Safety Manager. Resumes may be provided for Business’s key leaders as well.

**ARTICLE 9—REQUIRED ATTACHMENTS**

9.01 Provide the following information with the Statement of Qualifications:

- A. If Business is a Joint Venture, separate Qualifications Statements for each Joint Venturer, as required in Paragraph 1.02.
- B. Diverse Business Certifications if required by Paragraph 3.01.
- C. Certification of Business’s safety performance if required by Paragraph 4.02.
- D. Financial statements as required by Paragraph 5.01.



- E. Attachments providing additional information as required by Paragraph 8.02.
- F. Schedule A (Current Projects) as required by Paragraph 8.03.
- G. Schedule B (Previous Experience with Similar Projects) as required by Paragraph 8.04.
- H. Schedule C (Key Individuals) and resumes for the key individuals listed, as required by Paragraph 8.05.
- I. Additional items as pertinent.

This Statement of Qualifications is offered by:

Business: \_\_\_\_\_  
*(typed or printed name of organization)*

By: \_\_\_\_\_  
*(individual's signature)*

Name: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

Date: \_\_\_\_\_  
*(date signed)*

*(If Business is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)*

Attest: \_\_\_\_\_  
*(individual's signature)*

Name: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

Address for giving notices:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Designated Representative:

Name: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Phone: \_\_\_\_\_

Email: \_\_\_\_\_

**Schedule A—Current Projects**

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
<hr/>					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
<hr/>					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

**Schedule B—Previous Experience with Similar Projects**

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

**Schedule B—Previous Experience with Similar Projects**

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

**Schedule C—Key Individuals**

<b>Project Manager</b>			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
<b>Project Superintendent</b>			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

<b>Safety Manager</b>			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
<b>Quality Control Manager</b>			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

**NOTICE OF AWARD**

Date of Issuance:  
 Owner: City of Springfield Owner's Project No.:  
 Engineer: Mott MacDonald Engineer's Project No.: 502100062  
 Project: Springfield City Complex  
 Contract Name:  
 Bidder:  
 Bidder's Address:

You are notified that Owner has accepted your Bid dated **[date]** for the above Contract, and that you are the Successful Bidder and are awarded a Contract for:

**Construction of new City Complex: Police Station, City Hall, Fire Station, and Public Works Building**

The Contract Price of the awarded Contract is \$**[Contract Price]**. Contract Price is subject to adjustment based on the provisions of the Contract, including but not limited to those governing changes, Unit Price Work, and Work performed on a cost-plus-fee basis, as applicable.

**[Number of copies sent]** unexecuted counterparts of the Agreement accompany this Notice of Award, and one copy of the Contract Documents accompanies this Notice of Award, or has been transmitted or made available to Bidder electronically.

Drawings will be delivered separately from the other Contract Documents.

You must comply with the following conditions precedent within 15 days of the date of receipt of this Notice of Award:

1. Deliver to Owner **[number of copies sent]** counterparts of the Agreement, signed by Bidder (as Contractor).
2. Deliver with the signed Agreement(s) the Contract security (such as required performance and payment bonds) and insurance documentation, as specified in the Instructions to Bidders and in the General Conditions, Articles 2 and 6.
3. Other conditions precedent (if any): **[Describe other conditions that require Successful Bidder's compliance]**

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within 10 days after you comply with the above conditions, Owner will return to you one fully signed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

Owner: **City of Springfield**

By (signature): \_\_\_\_\_

Name (printed): \_\_\_\_\_

Title: \_\_\_\_\_

Copy: Engineer



## AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

This Agreement is by and between City of Springfield (“Owner”) and \_\_\_\_\_ (“Contractor”).

Terms used in this Agreement have the meanings stated in the General Conditions and the Supplementary Conditions.

Owner and Contractor hereby agree as follows:

### ARTICLE 1—WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows: **Construction of new the City Complex which consist of new Police Station, City Hall, Fire Station (if added), and Public Works Building (if added) with associated site work at 1141 Transmitter Rd, Springfield, FL 32401.**

### ARTICLE 2—THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: **Springfield City Complex**

### ARTICLE 3—ENGINEER

3.01 The Owner has retained **Mott MacDonald Florida, LLC** (“Engineer”) to act as Owner’s representative, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract.

3.02 The part of the Project that pertains to the Work has been designed by **Mott MacDonald Florida, LLC**

### ARTICLE 4—CONTRACT TIMES

4.01 *Time is of the Essence*

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.03 *Contract Times: Days*

A. The Work will be substantially complete within **510** days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within **540** days after the date when the Contract Times commence to run.

4.04 *Milestones (not applicable)*

4.05 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and

Milestones not achieved within the Contract Times, as duly modified. The parties also recognize the delays, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. *Substantial Completion:* Contractor shall pay Owner \$1,500 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.
  2. *Completion of Remaining Work:* After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner \$1,500 for each day that expires after such time until the Work is completed and ready for final payment.
  4. Liquidated damages for failing to timely attain Milestones, Substantial Completion, and final completion are not additive, and will not be imposed concurrently.
- B. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, for such delay, except for special damages (if any) specified in this Agreement.

#### 4.06 *Special Damages*

- A. Contractor shall reimburse Owner (1) for any fines or penalties imposed on Owner as a direct result of the Contractor's failure to attain Substantial Completion according to the Contract Times, and (2) for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Substantial Completion (as duly adjusted pursuant to the Contract), until the Work is substantially complete.
- B. After Contractor achieves Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times, Contractor shall reimburse Owner for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Work to be completed and ready for final payment (as duly adjusted pursuant to the Contract), until the Work is completed and ready for final payment.
- C. The special damages imposed in this paragraph are supplemental to any liquidated damages for delayed completion established in this Agreement.

## ARTICLE 5—CONTRACT PRICE

- 5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents, the amounts that follow, subject to adjustment under the Contract:
- A. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

## ARTICLE 6—PAYMENT PROCEDURES

### 6.01 *Submittal and Processing of Payments*

- A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

### 6.02 *Progress Payments; Retainage*

- A. Owner shall make progress payments on the basis of Contractor's Applications for Payment on or about the **30th** day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.
  - 1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.
    - a. **95** percent of the value of the Work completed (with the balance being retainage).
    - b. 95 percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).
- B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to **95** percent of the Work completed, less such amounts set off by Owner pursuant to Paragraph 15.01.E of the General Conditions, and less **100** percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

### 6.03 *Final Payment*

- A. Upon final completion and acceptance of the Work, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

### 6.04 *Consent of Surety*

- A. Owner will not make final payment, or return or release retainage at Substantial Completion or any other time, unless Contractor submits written consent of the surety to such payment, return, or release.

### 6.05 *Interest*

- A. All amounts not paid when due will bear interest at the rate of **0.00** percent per annum.

## ARTICLE 7—CONTRACT DOCUMENTS

### 7.01 *Contents*

- A. The Contract Documents consist of all of the following:
  - 1. This Agreement.

2. Bonds:
    - a. Performance bond (together with power of attorney).
    - b. Payment bond (together with power of attorney).
  3. General Conditions.
  4. Supplementary Conditions.
  5. **Contractual Provisions for FEMA & United States Department of Housing & Urban Development (HUD) Projects**
  6. Specifications (digital format) as listed in the table of contents of the project manual.
  7. Drawings (digital format) consisting of [number] sheets with each sheet bearing the following general title: **Springfield City Complex**
  8. Addenda (numbers [number] to [number], inclusive).
  9. Exhibits to this Agreement (enumerated as follows):
    - a. Contractor's Bid Submittal
    - b. Subcontractor/Supplier List
  10. The following which may be delivered or issued on or after the Effective Date of the Contract and are not attached hereto:
    - a. Notice to Proceed.
    - b. Work Change Directives.
    - c. Change Orders.
    - d. Field Orders.
    - e. Warranty Bond, if any.
- B. The Contract Documents listed in Paragraph 7.01.A are attached to this Agreement (except as expressly noted otherwise above).
- C. There are no Contract Documents other than those listed above in this Article 7.
- D. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

## **ARTICLE 8—REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS**

### **8.01 Contractor's Representations**

- A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:
1. Contractor has examined and carefully studied the Contract Documents, including Addenda.
  2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

3. Contractor is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
4. Contractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
5. Contractor has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
8. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.
9. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

#### 8.02 *Contractor's Certifications*

- A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 8.02:
  1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;

2. “fraudulent practice” means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;
3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and
4. “coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

8.03 *Standard General Conditions*

- A. Owner stipulates that if the General Conditions that are made a part of this Contract are EJCDC® C-700, Standard General Conditions for the Construction Contract (2018), published by the Engineers Joint Contract Documents Committee, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or “track changes” (redline/strikeout), or in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement.

This Agreement will be effective on **[indicate date on which Contract becomes effective]** (which is the Effective Date of the Contract).

Owner: City of Springfield

Contractor:

\_\_\_\_\_  
*(typed or printed name of organization)*

\_\_\_\_\_  
*(typed or printed name of organization)*

By: \_\_\_\_\_  
*(individual's signature)*

By: \_\_\_\_\_  
*(individual's signature)*

Date: \_\_\_\_\_  
*(date signed)*

Date: \_\_\_\_\_  
*(date signed)*

Name: \_\_\_\_\_  
*(typed or printed)*

Name: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

*(If [Type of Entity] is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)*

Attest: \_\_\_\_\_  
*(individual's signature)*

Attest: \_\_\_\_\_  
*(individual's signature)*

Title: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

Address for giving notices:

Address for giving notices:

\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Designated Representative:

Designated Representative:

Name: \_\_\_\_\_  
*(typed or printed)*

Name: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

Title: \_\_\_\_\_  
*(typed or printed)*

Address:

Address:

\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Phone: \_\_\_\_\_

Phone: \_\_\_\_\_

Email: \_\_\_\_\_

Email: \_\_\_\_\_

*(If [Type of Entity] is a corporation, attach evidence of authority to sign. If [Type of Entity] is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)*

License No.: \_\_\_\_\_  
*(where applicable)*

State: \_\_\_\_\_

## NOTICE TO PROCEED

Owner: City of Springfield Owner's Project No.: \_\_\_\_\_  
Engineer: Mott MacDonald Engineer's Project No.: 502100062  
Contractor: \_\_\_\_\_ Contractor's Project No.: \_\_\_\_\_  
Project: Springfield City Complex  
Contract Name: \_\_\_\_\_  
Effective Date of Contract: \_\_\_\_\_

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on **[date Contract Times are to start]** pursuant to Paragraph 4.01 of the General Conditions.

On that date, Contractor shall start performing its obligations under the Contract Documents. No Work will be done at the Site prior to such date.

In accordance with the Agreement: **[Select one of the following two alternatives, insert dates or number of days, and delete the other alternative.]**

The date by which Substantial Completion must be achieved is **[date for Substantial Completion, from Agreement]**, and the date by which readiness for final payment must be achieved is **[date for readiness, from Agreement]**.

**[or]**

The number of days to achieve Substantial Completion is **[number of days, from Agreement]** from the date stated above for the commencement of the Contract Times, resulting in a date for Substantial Completion of **[date, calculated from commencement date above]**; and the number of days to achieve readiness for final payment is **[number of days, from Agreement]** from the commencement date of the Contract Times, resulting in a date for readiness for final payment of **[date, calculated from commencement date above]**.

Before starting any Work at the Site, Contractor must comply with the following:

**[Note any access limitations, security procedures, or other restrictions]**

Owner: City of Springfield  
By (signature): \_\_\_\_\_  
Name (printed): \_\_\_\_\_  
Title: \_\_\_\_\_  
Date Issued: \_\_\_\_\_  
Copy: Engineer



## PERFORMANCE BOND

<p><b>Contractor</b></p> <p>Name: <b>[Full formal name of Contractor]</b></p> <p>Address <i>(principal place of business)</i>:  <b>[Address of Contractor's principal place of business]</b></p>	<p><b>Surety</b></p> <p>Name: <b>[Full formal name of Surety]</b></p> <p>Address <i>(principal place of business)</i>:  <b>[Address of Surety's principal place of business]</b></p>
<p><b>Owner</b></p> <p>Name: <b>City of Springfield</b></p> <p>Mailing address <i>(principal place of business)</i>:  <b>408 School Avenue  Springfield, FL 32401</b></p>	<p><b>Contract</b></p> <p>Description <i>(name and location)</i>:  <b>Springfield City Complex  1141 Transmitter Road, Springfield, FL 32401</b></p> <p>Contract Price: <b>[Amount from Contract]</b></p> <p>Effective Date of Contract: <b>[Date from Contract]</b></p>
<p><b>Bond</b></p> <p>Bond Amount: <b>[Amount]</b></p> <p>Date of Bond: <b>[Date]</b></p> <p><i>(Date of Bond cannot be earlier than Effective Date of Contract)</i></p> <p>Modifications to this Bond form:  <input type="checkbox"/> None <input type="checkbox"/> See Paragraph 16</p>	
<p>Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.</p>	
Contractor as Principal	Surety
<i>(Full formal name of Contractor)</i>	<i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<p><i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i></p>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
  - 3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;
  - 3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
  - 3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.
4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.
5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
  - 5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
  - 5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
  - 5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or
  - 5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

- 5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
  - 5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.
- 6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.
- 7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:
  - 7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
  - 7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and
  - 7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
- 8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.
- 9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
- 10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
- 11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.
- 12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.
- 13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such

statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

- 14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
  - 14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.
  - 14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.
  - 14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
  - 14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
16. Modifications to this Bond are as follows: **[Describe modification or enter “None”]**

**PAYMENT BOND**

<p><b>Contractor</b></p> <p>Name: <b>[Full formal name of Contractor]</b></p> <p>Address <i>(principal place of business):</i>  <b>[Address of Contractor’s principal place of business]</b></p>	<p><b>Surety</b></p> <p>Name: <b>[Full formal name of Surety]</b></p> <p>Address <i>(principal place of business):</i>  <b>[Address of Surety’s principal place of business]</b></p>
<p><b>Owner</b></p> <p>Name: <b>City of Springfield</b></p> <p>Mailing address <i>(principal place of business):</i>  <b>408 School Avenue  Springfield, FL 32401</b></p>	<p><b>Contract</b></p> <p>Description <i>(name and location):</i>  <b>Springfield City Complex  1141 Transmitter Road, Springfield, FL 32401</b></p> <p>Contract Price: <b>[Amount, from Contract]</b></p> <p>Effective Date of Contract: <b>[Date, from Contract]</b></p>
<p><b>Bond</b></p> <p>Bond Amount: <b>[Amount]</b></p> <p>Date of Bond: <b>[Date]</b></p> <p><i>(Date of Bond cannot be earlier than Effective Date of Contract)</i></p> <p>Modifications to this Bond form:  <input type="checkbox"/> None <input type="checkbox"/> See Paragraph 18</p>	
<p>Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.</p>	
Contractor as Principal	Surety
<i>(Full formal name of Contractor)</i>	<i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<p><i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i></p>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.
4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.
5. The Surety's obligations to a Claimant under this Bond will arise after the following:
  - 5.1. Claimants who do not have a direct contract with the Contractor
    - 5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
    - 5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).
  - 5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).
6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.
7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:
  - 7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
  - 7.2. Pay or arrange for payment of any undisputed amounts.
  - 7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.
9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.
10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.
11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.
14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.
16. Definitions
  - 16.1. *Claim*—A written statement by the Claimant including at a minimum:
    - 16.1.1. The name of the Claimant;
    - 16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;
    - 16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
    - 16.1.4. A brief description of the labor, materials, or equipment furnished;

- 16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
  - 16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
  - 16.1.7. The total amount of previous payments received by the Claimant; and
  - 16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.
- 16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic’s lien or similar statute against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of “labor, materials, or equipment” that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor’s subcontractors, and all other items for which a mechanic’s lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.
- 16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.
- 16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
- 16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
18. Modifications to this Bond are as follows: **[Describe modification or enter “None”]**



**Contractor's Application for Payment**

<b>Owner:</b> <u>City of Springfield</u>	<b>Owner's Project No.:</b> _____
<b>Engineer:</b> <u>Mott MacDonald</u>	<b>Engineer's Project No.:</b> <u>502100062</u>
<b>Contractor:</b> _____	<b>Contractor's Project No.:</b> _____
<b>Project:</b> <u>Springfield City Complex - (Civil/Site or Bldg Name)</u>	
<b>Contract:</b> _____	
<b>Application No.:</b> _____	<b>Application Date:</b> _____
<b>Application Period:</b> From _____ to _____	

1. Original Contract Price	\$	-
2. Net change by Change Orders	\$	-
3. Current Contract Price (Line 1 + Line 2)	\$	-
4. Total Work completed and materials stored to date (Sum of Column G Lump Sum Total and Column J Unit Price Total)	\$	-
5. Retainage		
a. <u>5%</u> X \$ - Work Completed	\$	-
b. <u>5%</u> X \$ - Stored Materials	\$	-
c. Total Retainage (Line 5.a + Line 5.b)	\$	-
6. Amount eligible to date (Line 4 - Line 5.c)	\$	-
7. Less previous payments (Line 6 from prior application)		
8. Amount due this application	\$	-
9. Balance to finish, including retainage (Line 3 - Line 4)	\$	-

**Contractor's Certification**

The undersigned Contractor certifies, to the best of its knowledge, the following:

(1) All previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with the Work covered by prior Applications for Payment;

(2) Title to all Work, materials and equipment incorporated in said Work, or otherwise listed in or covered by this Application for Payment, will pass to Owner at time of payment free and clear of all liens, security interests, and encumbrances (except such as are covered by a bond acceptable to Owner indemnifying Owner against any such liens, security interest, or encumbrances); and

(3) All the Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

**Contractor:** \_\_\_\_\_

**Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

<b>Recommended by Engineer</b>	<b>Approved by Owner</b>
<b>By:</b> _____	<b>By:</b> _____
<b>Title:</b> _____	<b>Title:</b> _____
<b>Date:</b> _____	<b>Date:</b> _____
<b>Approved by Funding Agency</b>	
<b>By:</b> <u>(Not applicable)</u>	<b>By:</b> <u>(Not applicable)</u>
<b>Title:</b> _____	<b>Title:</b> _____
<b>Date:</b> _____	<b>Date:</b> _____

**Progress Estimate - Lump Sum Work**

**Contractor's Application for Payment**

<b>Owner:</b>	City of Springfield	<b>Owner's Project No.:</b>	
<b>Engineer:</b>	Mott MacDonald	<b>Engineer's Project No.:</b>	502100062
<b>Contractor:</b>		<b>Contractor's Project No.:</b>	
<b>Project:</b>	Springfield City Complex - (Civil/Site or Bldg Name)		
<b>Contract:</b>			

Application No.: \_\_\_\_\_ Application Period: From \_\_\_\_\_ to \_\_\_\_\_ Application Date: \_\_\_\_\_

A	B	C	D	E	F	G	H	I
Item No.	Description	Scheduled Value (\$)	Work Completed		Materials Currently Stored (not in D or E) (\$)	Work Completed and Materials Stored to Date (D + E + F) (\$)	% of Scheduled Value (G / C) (%)	Balance to Finish (C - G) (\$)
			(D + E) From Previous Application (\$)	This Period (\$)				
<b>Original Contract</b>								
			-			-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
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						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
	<b>Original Contract Totals</b>	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -

**Progress Estimate - Lump Sum Work**

**Contractor's Application for Payment**

<b>Owner:</b>	City of Springfield	<b>Owner's Project No.:</b>	
<b>Engineer:</b>	Mott MacDonald	<b>Engineer's Project No.:</b>	502100062
<b>Contractor:</b>		<b>Contractor's Project No.:</b>	
<b>Project:</b>	Springfield City Complex - (Civil/Site or Bldg Name)		
<b>Contract:</b>			

Application No.: \_\_\_\_\_ Application Period: From \_\_\_\_\_ to \_\_\_\_\_ Application Date: \_\_\_\_\_

A	B	C	D	E	F	G	H	I
Item No.	Description	Scheduled Value (\$)	Work Completed		Materials Currently Stored (not in D or E) (\$)	Work Completed and Materials Stored to Date (D + E + F) (\$)	% of Scheduled Value (G / C) (%)	Balance to Finish (C - G) (\$)
			(D + E) From Previous Application (\$)	This Period (\$)				
<b>Change Orders</b>								
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
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						-		-
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						-		-
						-		-
						-		-
	<b>Change Order Totals</b>	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -
<b>Original Contract and Change Orders</b>								
	<b>Project Totals</b>	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -

**Progress Estimate - Unit Price Work**

**Contractor's Application for Payment**

<b>Owner:</b>	City of Springfield	<b>Owner's Project No.:</b>	
<b>Engineer:</b>	Mott MacDonald	<b>Engineer's Project No.:</b>	502100062
<b>Contractor:</b>		<b>Contractor's Project No.:</b>	
<b>Project:</b>	Springfield City Complex - (Civil/Site or Bldg Name)		
<b>Contract:</b>			

Application No.: \_\_\_\_\_ Application Period: From \_\_\_\_\_ to \_\_\_\_\_ Application Date: \_\_\_\_\_

A	B	C	D	E	F	G	H	I	J	K	L		
Bid Item No.	Description	Contract Information				Work Completed		Materials Currently Stored (not in G) (\$)	Work Completed and Materials Stored to Date (H + I) (\$)	% of Value of Item (J / F) (%)	Balance to Finish (F - J) (\$)		
		Item Quantity	Units	Unit Price (\$)	Value of Bid Item (C X E) (\$)	Estimated Quantity Incorporated in the Work	Value of Work Completed to Date (E X G) (\$)						
Original Contract													
					-		-		-		-		
					-		-		-		-		
					-		-		-		-		
					-		-		-		-		
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					-		-		-		-		
					-		-		-		-		
<b>Original Contract Totals</b>					\$	-		\$	-	\$	-	\$	-

**Progress Estimate - Unit Price Work**

**Contractor's Application for Payment**

<b>Owner:</b>	City of Springfield	<b>Owner's Project No.:</b>	
<b>Engineer:</b>	Mott MacDonald	<b>Engineer's Project No.:</b>	502100062
<b>Contractor:</b>		<b>Contractor's Project No.:</b>	
<b>Project:</b>	Springfield City Complex - (Civil/Site or Bldg Name)		
<b>Contract:</b>			

Application No.: \_\_\_\_\_ Application Period: From \_\_\_\_\_ to \_\_\_\_\_ Application Date: \_\_\_\_\_

A	B	C	D	E	F	G	H	I	J	K	L	
Bid Item No.	Description	Contract Information			Work Completed			Materials Currently Stored (not in G) (\$)	Work Completed and Materials Stored to Date (H + I) (\$)	% of Value of Item (J / F) (%)	Balance to Finish (F - J) (\$)	
		Item Quantity	Units	Unit Price (\$)	Value of Bid Item (C X E) (\$)	Estimated Quantity Incorporated in the Work	Value of Work Completed to Date (E X G) (\$)					
<b>Change Orders</b>												
					-		-		-		-	
					-		-		-		-	
					-		-		-		-	
					-		-		-		-	
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					-		-		-		-	
<b>Change Order Totals</b>					\$	-	\$	-	\$	-	\$	-
<b>Original Contract and Change Orders</b>												
<b>Project Totals</b>					\$	-	\$	-	\$	-	\$	-

**Stored Materials Summary**

**Contractor's Application for Payment**

<b>Owner:</b>	City of Springfield	<b>Owner's Project No.:</b>	
<b>Engineer:</b>	Mott MacDonald	<b>Engineer's Project No.:</b>	502100062
<b>Contractor:</b>		<b>Contractor's Project No.:</b>	
<b>Project:</b>	Springfield City Complex - (Civil/Site or Bldg Name)		
<b>Contract:</b>			

Application No.: \_\_\_\_\_ Application Period: From \_\_\_\_\_ to \_\_\_\_\_ Application Date: \_\_\_\_\_

A	B	C	D	E	F	G	H	I	J	K	L	M
Item No. (Lump Sum Tab) or Bid Item No. (Unit Price Tab)	Supplier Invoice No.	Submittal No. (with Specification Section No.)	Description of Materials or Equipment Stored	Storage Location	Application No. When Materials Placed in Storage	Materials Stored			Incorporated in Work			Materials Remaining in Storage (I-L) (\$)
						Previous Amount Stored (\$)	Amount Stored this Period (\$)	Amount Stored to Date (G+H) (\$)	Amount Previously Incorporated in the Work (\$)	Amount Incorporated in the Work this Period (\$)	Total Amount Incorporated in the Work (J+K) (\$)	
								-				-
								-				-
								-				-
								-				-
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								-				-
						<b>Totals</b>	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

## CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner:	City of Springfield	Owner's Project No.:	
Engineer:	Mott MacDonald	Engineer's Project No.:	502100062
Contractor:		Contractor's Project No.:	
Project:	Springfield City Complex		
Contract Name:			

This  Preliminary  Final Certificate of Substantial Completion applies to:

All Work  The following specified portions of the Work:

**[Describe the portion of the work for which Certificate of Substantial Completion is issued]**

Date of Substantial Completion: **[Enter date, as determined by Engineer]**

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 15.03.D of the General Conditions.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work must be as provided in the Contract, except as amended as follows:

Amendments to Owner's Responsibilities:  None  As follows:

**[List amendments to Owner's Responsibilities]**

Amendments to Contractor's Responsibilities:  None  As follows:

**[List amendments to Contractor's Responsibilities]**

The following documents are attached to and made a part of this Certificate:

**[List attachments such as punch list; other documents]**

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

Engineer

By *(signature)*: \_\_\_\_\_

Name *(printed)*: \_\_\_\_\_

Title: \_\_\_\_\_

**NOTICE OF ACCEPTABILITY OF WORK**

Owner:	City of Springfield	Owner's Project No.:	
Engineer:	Mott MacDonald	Engineer's Project No.:	502100062
Contractor:		Contractor's Project No.:	
Project:	Springfield City Complex		
Contract Name:			
Notice Date:	Effective Date of the Construction Contract:		

The Engineer hereby gives notice to the Owner and Contractor that Engineer recommends final payment to Contractor, and that the Work furnished and performed by Contractor under the Construction Contract is acceptable, expressly subject to the provisions of the Construction Contract's Contract Documents ("Contract Documents") and of the Agreement between Owner and Engineer for Professional Services dated **[date of professional services agreement]** ("Owner-Engineer Agreement"). This Notice of Acceptability of Work (Notice) is made expressly subject to the following terms and conditions to which all who receive and rely on said Notice agree:

1. This Notice has been prepared with the skill and care ordinarily used by members of the engineering profession practicing under similar conditions at the same time and in the same locality.
2. This Notice reflects and is an expression of the Engineer's professional opinion.
3. This Notice has been prepared to the best of Engineer's knowledge, information, and belief as of the Notice Date.
4. This Notice is based entirely on and expressly limited by the scope of services Engineer has been employed by Owner to perform or furnish during construction of the Project (including observation of the Contractor's Work) under the Owner-Engineer Agreement, and applies only to facts that are within Engineer's knowledge or could reasonably have been ascertained by Engineer as a result of carrying out the responsibilities specifically assigned to Engineer under such Owner-Engineer Agreement.
5. This Notice is not a guarantee or warranty of Contractor's performance under the Construction Contract, an acceptance of Work that is not in accordance with the Contract Documents, including but not limited to defective Work discovered after final inspection, nor an assumption of responsibility for any failure of Contractor to furnish and perform the Work thereunder in accordance with the Contract Documents, or to otherwise comply with the Contract Documents or the terms of any special guarantees specified therein.
6. This Notice does not relieve Contractor of any surviving obligations under the Construction Contract, and is subject to Owner's reservations of rights with respect to completion and final payment.

Engineer (*signature*): \_\_\_\_\_  
 Name (*printed*): \_\_\_\_\_  
 Title: \_\_\_\_\_



# STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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## STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

### ARTICLE 1—DEFINITIONS AND TERMINOLOGY

#### 1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
  2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
  3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
  4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
  5. *Bidder*—An individual or entity that submits a Bid to Owner.
  6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
  7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
  8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.
  9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
  10. *Claim*
    - a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the

requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.

- b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.
  - c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.
  - d. A demand for money or services by a third party is not a Claim.
11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.
13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.
15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
17. *Cost of the Work*—See Paragraph 13.01 for definition.
18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.
21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the

recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

22. *Engineer*—The individual or entity named as such in the Agreement.
23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.
  - a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.
  - b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
  - c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.
25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.
28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.
30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.
32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.



33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.
34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer’s review of the submittals.
36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.
37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.
39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers’ instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion of such Work.

43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.
44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
46. *Technical Data*
- Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.
  - If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.
  - Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.
47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.
48. *Unit Price Work*—Work to be paid for on the basis of unit prices.
49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 *Terminology*

- A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.
- B. *Intent of Certain Terms or Adjectives:* The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.
- C. *Day:* The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.
- D. *Defective:* The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
1. does not conform to the Contract Documents;
  2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
  3. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).
- E. *Furnish, Install, Perform, Provide*
1. The word “furnish,” when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
  2. The word “install,” when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
  3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.
  4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

- F. *Contract Price or Contract Times*: References to a change in “Contract Price or Contract Times” or “Contract Times or Contract Price” or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term “or both” is not expressed.
- G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

## ARTICLE 2—PRELIMINARY MATTERS

### 2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

- A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).
- B. *Evidence of Contractor’s Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.
- C. *Evidence of Owner’s Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

### 2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.
- B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

### 2.03 *Before Starting Construction*

- A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:
  - 1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;
  - 2. a preliminary Schedule of Submittals; and
  - 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work

into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.
- B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.
  - 1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
  - 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
  - 3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.
  - 4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

- A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.
- B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

### ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

#### 3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.
- C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.
- D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
- E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.
- F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
- G. Nothing in the Contract Documents creates:
  - 1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
  - 2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

#### 3.02 *Reference Standards*

- A. *Standards Specifications, Codes, Laws and Regulations*
  - 1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
  - 2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility

inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

### 3.03 *Reporting and Resolving Discrepancies*

#### A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements:* Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
2. *Contractor's Review of Contract Documents:* If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

#### B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:
  - a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or
  - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

### 3.04 *Requirements of the Contract Documents*

- A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.

- B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

### 3.05 *Reuse of Documents*

- A. Contractor and its Subcontractors and Suppliers shall not:
  - 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or
  - 2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

## **ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK**

### 4.01 *Commencement of Contract Times; Notice to Proceed*

- A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

### 4.02 *Starting the Work*

- A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

### 4.03 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the



established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

#### 4.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.
  - 1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.
  - 2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.
- B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

#### 4.05 *Delays in Contractor's Progress*

- A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.
- B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.
- C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:
  - 1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
  - 2. Abnormal weather conditions;
  - 3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and
  - 4. Acts of war or terrorism.

- D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:
1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
  2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
  3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.
- E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:
1. The circumstances that form the basis for the requested adjustment;
  2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
  3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
  4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
  5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.
- Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.
- F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.
- G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

## **ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS**

### **5.01 *Availability of Lands***

- A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

## 5.02 *Use of Site and Other Areas*

### A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.
  2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.
- B. *Removal of Debris During Performance of the Work:* During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.
  - C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment

and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

- D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

### 5.03 *Subsurface and Physical Conditions*

- A. *Reports and Drawings*: The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;
2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and
3. Technical Data contained in such reports and drawings.

- B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

- C. *Reliance by Contractor on Technical Data*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.

- D. *Limitations of Other Data and Documents*: Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:
1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
  2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;
  3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
  4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

#### 5.04 *Differing Subsurface or Physical Conditions*

- A. *Notice by Contractor:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:
1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
  2. is of such a nature as to require a change in the Drawings or Specifications;
  3. differs materially from that shown or indicated in the Contract Documents; or
  4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

- B. *Engineer's Review:* After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.
- C. *Owner's Statement to Contractor Regarding Site Condition:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.
- D. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- E. *Possible Price and Times Adjustments*
1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in

Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;
  - b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,
  - c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.
2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
- a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;
  - b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or
  - c. Contractor failed to give the written notice required by Paragraph 5.04.A.
3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.
- F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

#### 5.05 *Underground Facilities*

- A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:
1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
  2. complying with applicable state and local utility damage prevention Laws and Regulations;

3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;
  4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
  5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.
- B. *Notice by Contractor:* If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.
- C. *Engineer's Review:* Engineer will:
1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;
  2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;
  3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and
  4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.
- During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.
- D. *Owner's Statement to Contractor Regarding Underground Facility:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.
- E. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- F. *Possible Price and Times Adjustments*
1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown

or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
  - b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and
  - c. Contractor gave the notice required in Paragraph 5.05.B.
2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
  3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.
  4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

#### 5.06 *Hazardous Environmental Conditions at Site*

##### A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;
2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
3. Technical Data contained in such reports and drawings.

##### B. *Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures



- of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
  3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.
- D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.
- E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.
- F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.
- G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.
- H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special

- conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.
- I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
  - J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
  - K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

## **ARTICLE 6—BONDS AND INSURANCE**

### **6.01 *Performance, Payment, and Other Bonds***

- A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.
- B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.
- C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or

- Regulations, and must be issued and signed by a surety named in “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual’s authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.
- D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.
  - E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.
  - F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner’s termination rights under Article 16.
  - G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.
  - H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

#### 6.02 *Insurance—General Provisions*

- A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.
- B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.
- C. Alternative forms of insurance coverage, including but not limited to self-insurance and “Occupational Accident and Excess Employer’s Indemnity Policies,” are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.
- D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by

- Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.
- E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.
  - F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.
  - G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.
  - H. Contractor shall require:
    - 1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and
    - 2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.
  - I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.
  - J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.
  - K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

- L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.
- M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.
- N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

### 6.03 Contractor's Insurance

- A. *Required Insurance:* Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.
- B. *General Provisions:* The policies of insurance required by this Paragraph 6.03 as supplemented must:
  - 1. include at least the specific coverages required;
  - 2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;
  - 3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;
  - 4. apply with respect to the performance of the Work, whether such performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable; and
  - 5. include all necessary endorsements to support the stated requirements.
- C. *Additional Insureds:* The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:
  - 1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;
  - 2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;
  - 3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);

4. not seek contribution from insurance maintained by the additional insured; and
5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

#### 6.04 *Builder's Risk and Other Property Insurance*

- A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.
- B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.
- C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.
- D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.
- E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

#### 6.05 *Property Losses; Subrogation*

- A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against

Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.
  2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.
- B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.
1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.
- C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.
- D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

- A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.
- B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.
- C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

**ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES**

7.01 *Contractor's Means and Methods of Construction*

- A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.



- B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.
- C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

#### 7.04 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.
- B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

#### 7.05 *"Or Equals"*

- A. *Contractor's Request; Governing Criteria:* Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.
  - 1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:
    - a. in the exercise of reasonable judgment Engineer determines that the proposed item:
      - 1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

- 2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
  - 3) has a proven record of performance and availability of responsive service; and
  - 4) is not objectionable to Owner.
- b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:
- 1) there will be no increase in cost to the Owner or increase in Contract Times; and
  - 2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.
- B. *Contractor's Expense:* Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.
- C. *Engineer's Evaluation and Determination:* Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.
- D. *Effect of Engineer's Determination:* Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.
- E. *Treatment as a Substitution Request:* If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

#### 7.06 Substitutes

- A. *Contractor's Request; Governing Criteria:* Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.
1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.
  2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:
  - a. will certify that the proposed substitute item will:
    - 1) perform adequately the functions and achieve the results called for by the general design;
    - 2) be similar in substance to the item specified; and
    - 3) be suited to the same use as the item specified.
  - b. will state:
    - 1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;
    - 2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
    - 3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
  - c. will identify:
    - 1) all variations of the proposed substitute item from the item specified; and
    - 2) available engineering, sales, maintenance, repair, and replacement services.
  - d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.
- B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.
- C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

- E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.
- F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

#### 7.07 *Concerning Subcontractors and Suppliers*

- A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.
- B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.
- C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.
- D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.
- E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.
- F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.
- G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

- H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.
- I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.
- J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.
- K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.
- L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.
- M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

#### 7.08 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.
- C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.09 *Permits*

- A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

- A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.
- C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

- A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.
- B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.
- C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
  - 1. all persons on the Site or who may be affected by the Work;
  - 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
  - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
- E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.
- F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.
- G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.
- H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

- I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).
- J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

#### 7.14 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

#### 7.15 *Emergencies*

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

#### 7.16 *Submittals*

##### A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Contractor shall:
  - a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
  - b. determine and verify:
    - 1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;
    - 2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
    - 3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;
  - c. confirm that the Submittal is complete with respect to all related data included in the Submittal.
2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.



3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.
- B. *Submittal Procedures for Shop Drawings and Samples:* Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.
1. *Shop Drawings*
    - a. Contractor shall submit the number of copies required in the Specifications.
    - b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.
  2. *Samples*
    - a. Contractor shall submit the number of Samples required in the Specifications.
    - b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.
  3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Engineer's Review of Shop Drawings and Samples*
1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
  2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.
  3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
  4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will

document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.
6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.
8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

*D. Resubmittal Procedures for Shop Drawings and Samples*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.
2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.
3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

*E. Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs*

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:
  - a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.
  - b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.
  - c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.

- d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.
  2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03, 2.04, and 2.05.
- F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.
- B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:
1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and
  2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.
- C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
  2. normal wear and tear under normal usage.
- D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:
1. Observations by Engineer;
  2. Recommendation by Engineer or payment by Owner of any progress or final payment;
  3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
  4. Use or occupancy of the Work or any part thereof by Owner;
  5. Any review and approval of a Shop Drawing or Sample submittal;
  6. The issuance of a notice of acceptability by Engineer;
  7. The end of the correction period established in Paragraph 15.08;
  8. Any inspection, test, or approval by others; or

9. Any correction of defective Work by Owner.
- E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

- A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.
- B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

- A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.
- B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.
- C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

- D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.
- E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:
  - 1. Checking for conformance with the requirements of this Paragraph 7.19;
  - 2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
  - 3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.
- F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.
- G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

## **ARTICLE 8—OTHER WORK AT THE SITE**

### **8.01 *Other Work***

- A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.
- B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.
- C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.
- D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

- E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.
- F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

#### 8.02 *Coordination*

- A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:
  - 1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
  - 2. An itemization of the specific matters to be covered by such authority and responsibility; and
  - 3. The extent of such authority and responsibilities.
- B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

#### 8.03 *Legal Relationships*

- A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

- B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.
1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.
  2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.
- C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

## **ARTICLE 9—OWNER'S RESPONSIBILITIES**

### **9.01 *Communications to Contractor***

- A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

### **9.02 *Replacement of Engineer***

- A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

### **9.03 *Furnish Data***

- A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

### **9.04 *Pay When Due***

- A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

- A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.
- B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
- C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

- A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

- A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

- A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *Limitations on Owner's Responsibilities*

- A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.10 *Undisclosed Hazardous Environmental Condition*

- A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *Evidence of Financial Arrangements*

- A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

- A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.
- B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.



## ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

### 10.01 *Owner's Representative*

- A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

### 10.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

### 10.03 *Resident Project Representative*

- A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.
- B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

### 10.04 *Engineer's Authority*

- A. Engineer has the authority to reject Work in accordance with Article 14.
- B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.
- C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.
- D. Engineer's authority as to changes in the Work is set forth in Article 11.

E. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.05 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

## ARTICLE 11—CHANGES TO THE CONTRACT

### 11.01 *Amending and Supplementing the Contract*

- A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
- B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.
- C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

### 11.02 *Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders covering:
  - 1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
  - 2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
  - 3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and
  - 4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.
- B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

### 11.03 *Work Change Directives*

- A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

- B. If Owner has issued a Work Change Directive and:
  - 1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.
  - 2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

- A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.
- B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.
- B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.
- C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.
- B. An adjustment in the Contract Price will be determined as follows:

1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);
  2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or
  3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).
- C. *Contractor's Fee:* When applicable, the Contractor's fee for overhead and profit will be determined as follows:
1. A mutually acceptable fixed fee; or
  2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
    - a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;
    - b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;
    - c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;
    - d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
    - e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and
    - f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.
- B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

- A. *Purpose and Content:* Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

- B. *Change Proposal Procedures*

- 1. *Submittal:* Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.
- 2. *Supporting Data:* The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.
  - a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.
  - b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

- 3. *Engineer's Initial Review:* Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.
- 4. *Engineer's Full Review and Action on the Change Proposal:* Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change

Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.
- C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.
- D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

#### 11.10 *Notification to Surety*

- A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

### ARTICLE 12—CLAIMS

#### 12.01 *Claims*

- A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:
  1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
  2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;
  3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and
  4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.
- B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge

- and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.
- C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.
- D. *Mediation*
1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.
  2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.
  3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.
- E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.
- F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.
- G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

## **ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK**

### **13.01 *Cost of the Work***

- A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:
1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or



2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.
- B. *Costs Included:* Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:
1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.
  2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.
  3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
  4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.
  5. Other costs consisting of the following:
    - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
    - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are

consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

- 1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.

c. *Construction Equipment Rental*

- 1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts must cease when the use thereof is no longer necessary for the Work.
- 2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.
- 3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

- d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
- e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
- f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.

- g. The cost of utilities, fuel, and sanitary facilities at the Site.
  - h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
  - i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.
- C. *Costs Excluded*: The term Cost of the Work does not include any of the following items:
- 1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.
  - 2. The cost of purchasing, renting, or furnishing small tools and hand tools.
  - 3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
  - 4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
  - 5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
  - 6. Expenses incurred in preparing and advancing Claims.
  - 7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.
- D. *Contractor's Fee*
- 1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:
    - a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.
    - b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:
      - 1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.
      - 2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.
  - 2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change

Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

- E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

### 13.02 Allowances

- A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.
- B. *Cash Allowances*: Contractor agrees that:
1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
  2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment for any of the foregoing will be valid.
- C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.
- D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

### 13.03 Unit Price Work

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision

thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.

E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:
  - a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
  - b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.
2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.
3. Adjusted unit prices will apply to all units of that item.

**ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK**

14.01 *Access to Work*

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

- A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.
- B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

- D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:
1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
  2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
  3. by manufacturers of equipment furnished under the Contract Documents;
  4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and
  5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

- E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.
- F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

#### 14.03 *Defective Work*

- A. *Contractor's Obligation:* It is Contractor's obligation to assure that the Work is not defective.
- B. *Engineer's Authority:* Engineer has the authority to determine whether Work is defective, and to reject defective Work.
- C. *Notice of Defects:* Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.
- D. *Correction, or Removal and Replacement:* Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.
- E. *Preservation of Warranties:* When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.
- F. *Costs and Damages:* In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs,

losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

#### 14.04 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

#### 14.05 *Uncovering Work*

- A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.
- B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.
- C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.
  1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.
  2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

#### 14.06 *Owner May Stop the Work*

- A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work,

or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work will not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

**14.07** *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace defective Work as required by Engineer, then Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.
- B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.
- C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

**ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD**

**15.01** *Progress Payments*

- A. *Basis for Progress Payments:* The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.
- B. *Applications for Payments*
  - 1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.
  - 2. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation



establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and clear of all Liens; and (c) evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:
  - a. the Work has progressed to the point indicated;
  - b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and
  - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.
3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
  - a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
  - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
    - a. to supervise, direct, or control the Work;
    - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;
    - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;
    - d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; or
    - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
  5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.
  6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:
    - a. the Work is defective, requiring correction or replacement;
    - b. the Contract Price has been reduced by Change Orders;
    - c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
    - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
    - e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.
- D. *Payment Becomes Due*
1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.
- E. *Reductions in Payment by Owner*
1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:
    - a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

- b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
  - c. Contractor has failed to provide and maintain required bonds or insurance;
  - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
  - e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;
  - f. The Work is defective, requiring correction or replacement;
  - g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
  - h. The Contract Price has been reduced by Change Orders;
  - i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;
  - j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
  - k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens; or
  - l. Other items entitle Owner to a set-off against the amount recommended.
2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.
3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

#### 15.02 *Contractor's Warranty of Title*

- A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

#### 15.03 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time

- submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.
- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
  - C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.
  - D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.
  - E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.
  - F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

#### 15.04 *Partial Use or Occupancy*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without

significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through 15.03.E for that part of the Work.
2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.
4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.04 regarding builder's risk or other property insurance.

#### 15.05 *Final Inspection*

- A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

#### 15.06 *Final Payment*

##### A. *Application for Payment*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.
2. The final Application for Payment must be accompanied (except as previously delivered) by:
  - a. all documentation called for in the Contract Documents;
  - b. consent of the surety, if any, to final payment;
  - c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.

- d. a list of all duly pending Change Proposals and Claims; and
  - e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.
- B. *Engineer's Review of Final Application and Recommendation of Payment:* If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for payment. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.
- C. *Notice of Acceptability:* In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.
- D. *Completion of Work:* The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.
- E. *Final Payment Becomes Due:* Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

#### 15.07 *Waiver of Claims*

- A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim,

appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.

- B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

#### 15.08 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
  - 1. correct the defective repairs to the Site or such adjacent areas;
  - 2. correct such defective Work;
  - 3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and
  - 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.
- B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.
- C. If, after receipt of a notice of defect within 60 days and within the correction period, Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.
- D. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

- F. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph are not to be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

## **ARTICLE 16—SUSPENSION OF WORK AND TERMINATION**

### **16.01 *Owner May Suspend Work***

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

### **16.02 *Owner May Terminate for Cause***

- A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:
1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, or failure to adhere to the Progress Schedule);
  2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
  3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
  4. Contractor's repeated disregard of the authority of Owner or Engineer.
- B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:
1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and
  2. enforce the rights available to Owner under any applicable performance bond.
- C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.
- D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.
- E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects,



- attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.
- F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.
  - G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

#### 16.03 *Owner May Terminate for Convenience*

- A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
  - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
  - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and
  - 3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.
- B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

#### 16.04 *Contractor May Stop Work or Terminate*

- A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 days' written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.
- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, 7 days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The

provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

## **ARTICLE 17—FINAL RESOLUTION OF DISPUTES**

### **17.01 *Methods and Procedures***

- A. *Disputes Subject to Final Resolution:* The following disputed matters are subject to final resolution under the provisions of this article:
1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and
  2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.
- B. *Final Resolution of Disputes:* For any dispute subject to resolution under this article, Owner or Contractor may:
1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;
  2. agree with the other party to submit the dispute to another dispute resolution process; or
  3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

## **ARTICLE 18—MISCELLANEOUS**

### **18.01 *Giving Notice***

- A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only if delivered:
1. in person, by a commercial courier service or otherwise, to the recipient's place of business;
  2. by registered or certified mail, postage prepaid, to the recipient's place of business; or
  3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

### **18.02 *Computation of Times***

- A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

- A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

- A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

- A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination of the Contract or of the services of Contractor.

18.07 *Controlling Law*

- A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

- A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

- A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

18.10 *Headings*

- A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

**SECTION C-800**  
**SUPPLEMENTARY CONDITIONS**

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC® C-700 (2018 Edition). All provisions that are not so amended or supplemented remain in full force and effect.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions except as amended by Article 1. Additional terms used in these Supplementary Conditions have the meanings stated in Article 1 below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added thereto.

**ARTICLE 1 – DEFINITIONS AND TERMINOLOGY**

SC 1.01 Add the following language at the end of last sentence of Paragraph 1.01.A.8:

**The Change Order form to be used on this Project is EJCDC C-941 (latest edition). Owner approval is required before Change Orders are effective.**

SC 1.01 Delete Paragraph 1.01.A.15 in its entirety and replace with the following:

**The number of days or dates stated in the Agreement to complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation.**

SC 1.01 Delete Paragraph 1.01.A.35 in its entirety and replace with the following:

**Schedule of Submittals – A document prepared and maintained by the Contractor of required submittals and the time requirements to support scheduled performance of related construction activities.**

SC 1.01 Add the following new language at the end of the last sentence of Paragraph 1.01.A.50:

**A Work Change directive cannot change Contract Price or Contract Times without a subsequent Change Order.**

**ARTICLE 2 – PRELIMINARY MATTERS**

SC 2.01 Add the following new language at the end of the last sentence of Paragraph 2.01.B:

**Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under the provision.**

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SC 2.01 Add the following new language at the end of the last sentence of Paragraph 2.01.C:

**Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under the provision.**

SC 2.02 Amend the first sentence of Paragraph 2.02.A to read as follows:

**A. Owner shall furnish to the Contractor one copy of the Contract Document (including one fully executed counter part of the Agreement) and one copy in electronic portable document format (PDF).**

SC 2.02 Delete Paragraph 2.02.B in its entirety and replace with the term **[Deleted]**.

SC 2.04 Add the following Paragraph immediately after Paragraph 2.04.B:

**C. Additionally, the Contractor shall submit the pre-construction video and photographs at the Pre-Construction Meeting.**

SC 2.06 Delete Paragraphs 2.06.A., B., and C. in their entirety and replace with the term **[Deleted]**.

### ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

SC 3.01 Add the following new language immediately following 3.01.G:

**H. In case of difference between Drawings and Specifications, the Specifications shall govern. In case of discrepancy in the figures, in the Drawings, or in the Specifications, the matter shall be promptly submitted to the Engineer, who shall promptly make a determination in writing. Any adjustment by the Contractor without such a determination shall be at its own risk and expense.**

**I. In the case of a discrepancy in dimensions on the Drawings, the figured dimensions (unless obviously incorrect) shall govern over scaled dimensions.**

**J. In the event that the General Conditions, FEMA and HUD Supplemental Conditions, and other funding agencies Supplemental Conditions, Special Provisions and other provisions of the Bidding Documents are materially in conflict, FEMA and HUD Supplemental Conditions, and other funding agencies Supplemental Conditions shall take precedence over the other provisions for all work performed under the Contract unless the provisions herein are more stringent, then the most stringent condition will apply at the sole discretion of the Engineer.**

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

SC 4.01 Delete Paragraph 4.01.A in its entirety and add the following in its place:

- A. Notice to Proceed – The Owner will, after executing the Contract, issue to the Contractor in writing a Notice to Proceed. The beginning of the time allotted for the Contract completion will be 10 days after the date of the Notice to Proceed, or the day on which Work is actually started, whichever occurs first.**

SC 4.01 Add the following new language immediately following 4.01.A:

- B. Prosecution of Work – The Contractor shall begin the Work to be performed under the Contract within 10 days after issuance of the Notice to Proceed, and shall give the Engineer definite notice of his intention to start work at least 72 hours in advance of beginning work. During the progress of the Work, the Contractor shall notify the Engineer at least 24 hours before they expect to be ready to undertake any particular features of the Work in order that proper inspection may be provided.**
- C. The Contractor must continuously and diligently prosecute the Work in such order and manner to complete the Work in the specified time. The Contractor shall employ an ample workforce and provide construction plan properly adapted to the Work and of sufficient capacity and efficiency to accomplish the Work in a safe and workmanlike manner at the rate of progress deemed necessary to insure its completion within the time set forth in the Contract. Each operation shall be begun as soon after the Contract is awarded as conditions will permit. Each class of work will be expected to progress from the date it is begun until completed. All plant and equipment shall be maintained in good working order and provision shall be made for immediate emergency repairs.**
- D. Should the Contractor fail to maintain a satisfactory rate of progress, the Owner will require that workforce be augmented, tools and equipment packages be adjusted, or an adjustment of approach to project be effected in order that the Work be expedited to match the required progress schedule and maintained there. Should the Contractor fail to furnish suitable or sufficient tools, machinery, equipment or force for the proper prosecution of the Work, the Owner may withhold all estimates which are or may become due until their orders are complied with or the Contract may be annulled as hereinafter provided.**

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- E. Should the prosecution of the Work be discontinued by the Contractor, with the consent of the Owner, the Contractor shall notify the Engineer in writing at least 24 hours before resuming operations.**

SC 4.02 Add the following new language immediately following 4.02.A:

- B. Prior to start of construction, digital photographs shall be taken at sufficient locations and angles to document job site conditions. Each photograph shall contain the following information:**
  - 1. The location and direction of photo, in the photograph, by use of a small chalkboard or similar method.**
  - 2. All photographs shall be submitted on USB flash drive properly labeled with project name/number. When more than one flash drive is required, all shall be labeled 1 of X, 2 of X, where X is the total number of flash drives provided.**
- C. A video recording shall also be submitted. Video must be digital format submitted on USB flash drive, clear full color and properly labeled and documented. There will e no separate payment made for photographic work and no progress payments made until acceptable photographic documentation is provided.**

SC 4.03 Delete Paragraph 4.03.A in its entirety and replace with the following:

- A. The Engineer will establish bench marks and horizontal control points and will establish an offset line. From these points, the Contractor shall lay out the work by establishing all lines and grades at the site necessary to control the work, and shall be responsible for all measurements that may be required for execution of the work. Second order leveling shall be used by the Contractor in establishing elevations and all levels shall be looped in or closed. All survey data shall be recorded in accordance with standard and approve methods. All field notes, sketches and computations made by the Contractor in establishing control points shall be available to the Engineer at all times.**
- B. The Contractor shall furnish, at his expense, all stakes, pins, platforms, equipment, and labor as may be required in laying out any part of the work from the control points established by the Engineer. It shall be the responsibility of the Contractor to maintain and preserve all stakes and markers established by him until authorized to remove them. If any of the control points established by the Engineer are destroyed by or through negligence of the Contractor, they may be replaced by the Engineer, and the expense of replacement will be deducted from any amount due or which may become due the Contractor.**

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SC 4.05 DELAYS IN CONTRACTOR'S PROGRESS

**Weather delays will be agreed upon by Owner, Engineer and Contractor and will be amended in the Contract with a Change Order.**

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS;  
HAZARDOUS ENVIRONMENTAL CONDITIONS

SC 5.02 Add the following new language immediately following 5.02.B:

- 1. The job shall be kept clean at all times. Loose dirt shall not be allowed to clog ditches or cover sidewalks. Soft clay or other undesirable material shall be removed from the street, sidewalks, or ditches. The Owner reserves the right to demand that the Contractor's forces be diverted to the clean-up at any time that condition of street, driveways, sidewalks, or private property warrants such diversion. Such diversion of the Contractor's forces will not entitle the Contractor to any extension of time or additional compensation.**

SC 5.02 Add the following new language immediately following 5.02.D:

- E. Protection of property and others: Buildings, sidewalks, fences, shade trees, lawns and all other improvements shall be duly protected by the Contractor. Property obstructions, such as sewers, drains, water or gas pipes, conduits, railroads, poles, walls, posts, bridges, etc., shall be carefully protected from injury and shall not be displaced if avoidable.**
  - 1. If the construction of the Project shall render it necessary to move property, including privately owned public utility facilities located in public streets, highways or other public places, and all other types of property, the removal thereof shall be at the expense and risk of the Contractor. The Contractor is to obtain the consent of the Owners or others in charge, and before commencing, shall confer with them as to the best manner of protecting the interest involved.**
  - 2. Except as specifically provided in the Specifications, the Contractor shall not do any work that would affect any roadway railway track, pipeline, telephone, telegraph, or electric transmission line, or other structure, nor enter upon the right-of-way or other lands appurtenant thereto, until the Contractor has secured authority therefor from the proper parties.**
  - 3. If the Owner's utilities are damaged by the Contractor due to negligence and repaired by the Owner, the cost for the repair shall be reimbursed to the Owner prior to submittal of the following pay request.**

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4. **Should there be unexpected discoveries such as prehistoric artifacts pottery or ceramics, stone tools, or any other physical remains that could be associated with Native American cultures are encountered at any time, the project should cease all activities involving subsurface disturbance in the immediate vicinity of such discoveries. The applicant, or other designee, should contact the Florida Department of State, Division of Historical Resources.**
5. **In the event that unmarked human remains are encountered during permitted activities, all work must stop immediately, and the proper authorities notified in accordance with Section 872.05, *Florida Statute*.**

SC 5.03 Delete Paragraphs 5.03.A and 5.03.B in their entirety and replace with:

**Any reports of exploration or test of subsurface conditions at or adjacent to the site are included on the drawings or included in the specifications. If none are shown or included, then none are known by Owner.**

SC 5.05 Add the following new language immediately after 5.05.A.5:

6. **In areas where new waterline are proposed, the Contractor is responsible to locate and pothole (expose top) water mains where the new waterline will be constructed. Should the Contractor have utility location equipment which identifies the utility depth, this method will be acceptable upon demonstration that the depths are accurate. No excavation shall begin for a section of waterline until all utilities for that section have been located.**

SC 5.06 Delete Paragraphs 5.06.A. and B. in their entirety and replace with project specific conditions (if any) related to past and current hazardous environmental conditions at project location.

*Any reports or drawings related to hazardous environmental conditions at the site are included on the drawings or included in the specifications. If none are shown or included, then none are known to Owner.*

SC 5.06 Add the following Paragraph immediately after Paragraph 5.06.E:

1. **The removal, encapsulation or enclosure, storage and disposal of pipe materials containing asbestos shall be in accordance with Section 455.301 through 455.309 of the Florida State Statutes, American Water Works Association Manual of Water Supply Practices No. M16 “Work Practices for Asbestos-Cement Pipe”, OSHA 29 CFR 1910.100, 1926.1101 Appendix F, Asbestos NESHAP; 40CFR 61-Subpart M, 40CFR 763 Appendix D and all**

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**other industry and regulatory requirements or latest edition. There shall be no additional payment for this item.**

ARTICLE 6 – BONDS AND INSURANCE

SC 6.01 Add the following Paragraph immediately after Paragraph 6.01.A:

- 1. Required Performance Bond Form: The performance bond that the Contractor furnishes will be in the form specified by the Owner/Client/Agency. If form is not specified the Performance Bond that the Contractor furnishes will be in the form of EJCDC C-610, Performance Bond 2018 Edition.**
- 2. Required Payment Bond Form: The payment bond that the Contractor furnishes will be in the form specified by the Owner/Client/Agency. If form is not specified the Payment Bond that the Contractor furnishes will be in the form of EJCDC C-615, Payment Bond 2018 Edition.**

SC 6.02 – 6.06 Delete these conditions (6.02, 6.03, 6.04, 6.05 and 6.06) in their entirety and replace with the following:

**A. The Contractor shall procure and shall maintain during the life of the Contract:**

**1. Standard Insurance Coverage**

- a. The Contractor shall furnish the City with Certificates of Insurance with original endorsements affecting coverage. The certificates and endorsements for each policy must be received and signed by a person authorized by the insurer to bind coverage on its behalf. The certificates and endorsements must be received and approved by the City before the Contractor or any subcontractors, vendors, or suppliers begin work under the contract.**
- b. The minimum insurance coverage and limits required are shown by coverage line below. Failure of the Contractor to identify deficiencies in any insurance provided by subcontractors, vendors, or suppliers shall not relieve subcontractors, vendors, or suppliers from any insurance obligations.**
- c. All deductibles and self-insured retentions must be shown clearly on the Certificates of Insurance and approved by the City. The City reserves the right to reject these amounts but shall not do so unreasonably.**
- d. Insurance coverage shall be in force throughout the term of the Agreement and continue up until the end of the warranty period. The City shall be provided 30 days' notice of cancellation or modification of any policies. In the event the contractor fails to provide acceptable evidence of current insurance within seven (7) days of receipt of written notice at any time during the term of the Agreement, the City shall have the right to consider the**

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**Agreement breached which breach shall justify City's termination of it. If coverage on the Certificates of Insurance is shown to expire prior to the end of the Agreement, Contractor shall furnish Certificates of Insurance evidencing renewal of such coverage to the City.**

- 2. Required coverage is as follows:**
  - a. Workers Compensation and Employer's Liability**
    - 1) Workers' compensation insurance providing statutory benefits as required in the state of Florida and employers' liability with limits of not less than:**
      - I. \$1,000,000 E.L. Each Accident**
      - II. \$1,000,000 E.L. Disease - Each Employee**
      - III. \$1,000,000 E.L. Disease - Policy Limit**
    - 2) The policy shall include a waiver of subrogation in favor of the City. The certificate must clearly identify that coverage applies in the state the Contractor, Subcontractor, Vendor, or Supplier is located and includes coverage for Florida as required by statute.**
    - 3) Contractor shall not be permitted to use any employee, subcontractor, or subcontractor's employee for the work performed under the Agreement who is exempt or purports to be exempt from Worker's Compensation insurance.**
  - b. Commercial General Liability Insurance**
    - 1) Written on ISO form CG2010 11/85 or CG2010 10/01 or equivalent. The City shall be named as an additional insured. The minimum limits of coverage shall be as follows:**
      - I. \$2,000,000 each occurrence for Bodily Injury and Property Damage.**
      - II. \$2,000,000 General Aggregate.**
      - III. \$2,000,000 Products and Completed Operations.**
      - IV. \$2,000,000 Personal and Advertising Injury (with the standard contractual and employee exclusions deleted).**
      - V. Employees and Volunteers as Additional Insured for both on-going and completed operations.**
      - VI. Broad Form Property Damage including underground, explosion, and collapse hazards (X,C,U); or no exclusion for Exclusion - Damage to Work Performed by Subcontractors on Your Behalf (CG 22 94 or 22 95).**
      - VII. Blanket Contractual Liability.**
      - VIII. Independent Contractor's Liability.**

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**IX. Additional Insured - Owners, Lessees Or Contractors - Completed Operations (ISO form CG 20 37).**

**B. Other Insurance Requirements**

- 1. All insurance to be obtained by Contractor, Subcontractor, Vendor, or Supplier under the foregoing provisions shall be written by insurance companies authorized and licensed to do insurance business in the State of Florida with an A.M. Best rating of an "A-" or better. All liability and automobile insurance shall contain a severability of interest clause (a policy provision clarifying that, except with respect to the coverage limits, the insurance applies to each insured as though a separate policy were issued to each; Thus, a policy containing such a clause will cover a claim made by one insured against another insured).**
- 2. The Contractor's insurance coverages shall be the primary insurance with respect to the City's, its officials', employees', and volunteers' insurances. Any insurance and self-insurance maintained by the City, its officials, officers, employees, or volunteers shall be in excess of Contractor's insurances and shall not contribute with it.**
- 3. The Contractor's insurances shall be on an occurrence basis as opposed to a claims-made basis.**
- 4. Separation of Insured: The definition of insured shall read as follows: "*The insurance afforded applies separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the company's liability. The company, in this context, is Contractor's insurance company.*" If no such definition of the insured is quoted in the insurance, Contractor must provide "Cross Liability Clause" or "Severability of Interests Clause" endorsements for all liability insurances.**
- 5. Before permitting any Sub-subcontractor and/or Sub-supplier to perform scope under the Subcontract or Purchase Order, the Contractor shall require that the Sub-subcontractor and/or Sub-supplier maintains insurance in like form and amounts to that required herein. The Contractor shall be responsible to ensure the Sub-subcontractor and/or Sub-supplier maintains insurance in like form and amounts and shall provide evidence of it to City of Springfield if requested.**

**C. Waiver of Subrogation**

- 1. All insurance coverage maintained by the Contractor and all Subcontractors shall include a waiver of any right of subrogation of the insurers thereunder against the City, employees, insurers, and underwriters, and of any right of the insurers to any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any person insured under any such policy. Contractor and all Subcontractors further waive all claims and all rights of subrogation against the City,**

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employees, insurers, and underwriters for loss of, or damage to, Contractor/Subcontractor scope, tools, machinery, equipment, material, supplies, or any other losses within the scope of any insurance maintained by Contractor/Subcontractor.

**D. Indemnification**

1. To the fullest extent permitted by law, the Contractor and all Subcontractors shall indemnify and hold harmless the City, its consultants, and employees from and against claims, damages, losses, and expenses, including but not limited to attorney's fees, arising out of or resulting from the performance of the Contractor/Subcontractor work under this contract, provided that such claim, damage, loss or expense is 1) attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including loss of use resulting therefrom; and, 2) is caused in whole or in part by any negligent act or omission of the Contractor, Subcontractor, the Subcontractor's Sub-subcontractors, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss or expense is caused in part by a party indemnified hereunder.

**E. Builder Risk Insurance - Insurance on Building while under Construction –  
Builder's Risk Coverage**

1. The Contractor shall purchase and maintain builder's risk insurance in the amount of the initial contract amount plus the values of subsequent modifications, change orders, and loss of materials supplied or installed by others comprising the value of the entire project at the site on a replacement cost basis. The policy shall cover sinkholes, wind, and flood damage. Such insurance shall be maintained, unless otherwise provided in the contract or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made or until no person or entity other than the City has an insurable interest in the property to be covered, whichever is earlier. The insurance shall include the interests of the City, General Contractor and subcontractors as interest may appear in the project.
2. The Contractor shall insure or be wholly responsible for all materials destined to become a part of the completed structure when such materials are stored away from the site of the work. The insurance shall include the interests of the City, General Contractor and subcontractors as interest may appear in the project.
3. The Contractor shall separately insure or be wholly responsible for all Contractor's equipment, tools, scaffolding, staging, towers, forms, and temporary buildings, owned, borrowed, or rented by Contractor and Subcontractors, and all materials and

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**supplies which are not intended to become a part of the project. Evidence of such coverage will be supplied to the City upon request.**

- F. The insurance shall be written on a Special Covered Cause of Loss form and shall include theft, vandalism, malicious mischief, collapse, false-work, temporary buildings, flood (including water damage), earthquake, and if applicable, all below and above ground structures, piping, foundations including underground water and sewer mains, piling including the ground on which the structure rests. The Contractor is responsible for any deductible or self-insured retention contained within the insurance program.**
- G. Commercial Auto Insurance shall be written on ISO form CA 00 01 or equivalent. The City shall be named as an additional insured. The minimum limits of coverage shall be as follows:**
- 1. Bodily Injury and Property Damage: \$1,000,000 combined single limit.**
  - 2. Any auto coverage includes Hired Auto Liability and Non-Owned Auto Liability.**
  - 3. The policy must cover owned/hired and non-owned employee vehicles.**
- H. Excess or Umbrella Liability coverage is required. The minimum limits of coverage shall be as follows**
- 1. General Aggregate of \$20,000,000**
  - 2. Each Occurrence \$20,000,000**

## ARTICLE 7 – CONTRACTOR’S RESPONSIBILITIES

SC 7.02 Add the following new language immediately after 7.02.B:

- C. During the entire course of the Project there will be construction meetings. Depending on Project progress or criticality, frequency can vary from weekly, bi-weekly or monthly and will be determined by Engineer at their own discretion. Location, dates, and times will be established at the Pre-construction Conference. Construction meetings shall be attended by Contractor, Engineer, and Owner Representative. The main agenda will be to review construction issues, project progress, and partial pay estimates. The Contractor shall be required to submit all pay estimates at the meeting; no exceptions.**

SC 7.03 Add the following new language immediately after 7.03.C:

- D. Contractor shall be responsible for the cost of any overtime pay or other expense incurred by the Owner for Engineer’s services (including those of the Resident Project Representative, if any), Owner’s Representative,**

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**and construction observation services, occasioned by the performance of Work on Saturday, Sunday, any legal holiday, or as overtime on any regular work day. If Contractor is responsible but does not pay, or if the parties are unable to agree as to the amount owed, the Owner may impose a reasonable set-off against payments due under Article 15.**

SC 7.04 Add the following new language immediately after 7.04.C:

**D. The Contractor shall provide a suitable field office for the Representatives of the Engineer which shall be located on or adjacent to the City Complex site as directed by Engineer. It shall be independent of other buildings or office space used by the Contractor and be not less than 10 feet wide, 16 feet long, and 7 feet high; roofed and weather tight; contain two suitable work desks (or tables and drawers) and two chairs; contain a micro-wave oven and a mini refrigerator-freezer (4.0 cubic feet minimum); and have two windows and an outside door. It shall be portable and when deemed necessary shall be moved around the job site so the building will be convenient to the Work. The building shall be provided with heating and cooling facilities to maintain a comfortable temperature. The furnishing of this building and the cost of its utilities shall be considered as incidental to the Work and compensation shall be included in the Contract lump sum prices for pay items of the Work.**

SC 7.07 Amend Paragraph 7.07.A by adding the following text:

The Contractor shall not award work valued at more than 50 percent of the Contract price less cost of direct purchased items and the Sales Tax Exemption Agreement to Subcontractor(s), without providing prior written approval of the Owner/Client/Agency.

SC 7.09 Add the following new paragraph immediately after Paragraph 7.09.A:

**B. In addition to other permit requirements the Contractor shall acquire an NPDES Stormwater permit and implement appropriate pollution prevention techniques to minimize erosion and sedimentation and properly manage stormwater. The NPDES permit for this construction shall be applied and paid for by the Contractor. Compliance with NPDES permit, including inspections by a qualified stormwater management inspector, shall be the responsibility of the Contractor. All costs associated with this work shall be included in the appropriated bid item. There will be no extra payment for this item. Fine(s), if any, imposed by any Federal, State and Local regulatory agencies due to Contractor negligence, will be deducted from the Contractor's final payment, if not paid by the Contractor.**

SC 7.10 Add the following new paragraph immediately after Paragraph 7.10.A:

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- B. Should Owner be exempt from payment of sales and compensating use taxes of the State of [name of state where project is located] and of cities and counties thereof on all materials to be incorporated into the work then the following provisions apply:**
- 1. Owner will furnish the required certificates of tax exemption to Contractor for use in the purchase of supplies and materials to be incorporated into the Work.**
  - 2. Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.**

SC 7.12 Add the following new paragraph immediately after Paragraph 7.12.A:

- B. Record Drawings shall be provided in both print and electronic format upon completion of the Project. Information included on the Record Drawings shall include, but not be limited to, the following:**
- 1. Sewer Project:**
    - a. Location and top elevation of all sanitary sewer manholes.**
    - b. Invert elevation, size, material type and slope of all pipes entering and exiting manholes.**
    - c. Location of sanitary sewer service lateral endpoints.**
    - d. Location size and material type of all sanitary sewer force mains including location and designation of all bends, valves, etc.**
    - e. Detailed survey of all pumping station sites including location of fence, gates, wetwell, valve box, control panel, water service, backflow preventer, service pole, by-pass connection and any other surface features as may be present.**
  - 2. Water Projects:**
    - a. Location, size and material type of all potable water mains including location of all bends, valves, junctions, dead end sections, etc.**
    - b. Location of all potable water service lines and meters.**
    - c. Location of all fire hydrants and flush valves.**
    - d. Detailed survey of all water well sites including, but not limited to, location and size of well, well building, chlorine room, chlorine lines and injection points, service pole, fence gates, and any other surface features as may be present.**
  - 3. Storm Drain/Paving Project:**
    - a. Location, size, material type, and slope with direction of flow for all storm drain piping, entering and exiting inlets manhole or other structures including discharge and inlet ends of pipes.**
    - b. Location, top elevation, invert and description of type for all inlets, manholes, junction boxes and pipe end treatments.**

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- c. **Finished grade shots and cross sections of all paved surfaces sufficient to determine slope and direction of flow for stormwater as well as high and low points.**
  - d. **Top of curb and sidewalk elevations.**
  - e. **Description of surface paving materials used and limits of differing material types (i.e. asphalt, concrete, paving stones, etc).**
  - f. **Location and limit of riprap rubble or other erosion control features such as berms, ditch checks, etc.**
  - g. **Cross sections of all ditches and swales.**
  - h. **Cross sectional data and contours for all stormwater treatment retention/detention ponds.**
  - i. **Detailed information on all stormwater retention/detention pond discharge structures such as weir invert, weir length, orifice hole diameter, orifice pipe size and elevation, top and bottom elevation of all skimming devices included on structure, etc.**
  - j. **Locations and type of all signs.**
  - k. **Location and description of all pavement markings and messages.**
- 4. Treatment Plant Facilities:**
- a. **Top and inverts of all structures, including location of all access ways and hatches.**
  - b. **Location, invert and material type for all yard piping and pipes entering and leaving all structures, tanks, etc., including all junctions, bends and non-connecting crossings identified.**
  - c. **All building corners finished floor elevations, sidewalks, roadways, driveways, fences, gates curbs, and sufficient cross sections and spot elevations to determine slope and direction of flow for stormwater runoff.**
- C. The Contractor is advised to keep accurate records during the course of construction on all items of work and especially with regards to pipe size and/or material type changes, locations of bends, etc., that may be difficult to determine at the completion of the project. Written references to above ground features should be noted for these types of items to facilitate the inclusion on the final record drawings. The final record drawings shall be prepared in AutoCAD format, in a professional manner, and be certified by a professional surveyor registered in the State of Florida. Two printed copies of the final record drawings shall be provided to the Engineer for approval and verification that all required information has been provided. Upon approval of the final record drawings by the Engineer, the Contractor shall provide five (5) printed copies, signed and sealed by a professional surveyor licensed in the State of Florida, along with one electronic copy on Flash Drive to include any plot styles, text styles, line types, etc., required to open and print the final record drawings.**

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SC 7.13 Add the following new paragraph immediately after Paragraph 7.13.J:

**K. It shall be the Contractor's sole responsibility to maintain adequate traffic control and to provide detours around the construction activities. Unless approved by Owner in writing, no street shall remain closed overnight. In addition, the Contractor shall cooperate with local residents in gaining access to their homes during working hours and shall assist at all times when vehicles experience trouble due to construction activities. The Contractor shall be responsible for maintenance of traffic in accordance with FDOT requirements on all FDOT roadways. Contractor to submit maintenance of traffic plan for Engineer and FDOT approval prior to starting any construction.**

SC 7.15 Add the following new Paragraph immediately after Paragraph 7.15.A:

**B. In the event of a storm or a threat of a storm, Owner may, at its discretion, require Contractor to secure the work site and all loose materials, to stabilize all equipment at the work site, and to suspend the Work until authorized by Owner to resume the Work. No adjustment to the contract price shall be made on account of such action by the Owner.**

SC 7.16 Add the following new language immediately after Paragraph 7.16.A.1.c:

**d. Contractor shall furnish a written certification from the manufacturers that they have examined plans and specifications of the project and their equipment and material are suitable and approved for the intended use. (Use the following form):**

**MANUFACTURER'S CERTIFICATION**

**The Contractor shall require the manufacturer or manufacturer's representative to place the following certification on data submittal transmittals:**

**\*This is to certify that we have examined the Plans and Specifications for this Project and have ascertained that this equipment or materials is suitable for the purpose and use intended.**

---

**Authorized Signature**

**ARTICLE 10 – ENGINEER'S STATUS DURING CONSTRUCTION**

SC 10.03 Add the following new Paragraph immediately after Paragraph 10.03.B:

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- C. Inspectors employed by the Engineer or Owner will be authorized to inspect all work and materials which are to become a part of the completed project. Inspectors will have no authority to revoke, alter or waive any requirement of the Specifications or to make any changes in the Plans. Each Inspector will be authorized to call the attention of the Contractor to any failure of the work to conform to the Plans or the Specifications and will have authority to suspend the work affected until any questions at issue can be referred to and decided by Engineer. The Inspector will have no authority to delay the Contractor by failure to inspect the work and materials with reasonable promptness.**

ARTICLE 11 – CHANGES TO THE CONTRACT

SC 11.07 Add the following new language immediately after the last sentence of 11.07.B.1:

**In no event shall any adjustment in contact price be made on account of delay, impact claims or similar claims.**

SC 11.08 Add the following new Paragraph immediately after 11.08.B:

**C. All requests for change of contract times (time extensions) shall be submitted with the monthly Pay Request. Contractor's request for extension of contract time for a prior pay period will not be considered.**

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

SC 15.01 Add the following new paragraph immediately after Paragraph 15.01.B.4:

**5. No payment will be made that would deplete the retainage, place in escrow any funds that are required for retainage, or invest the retainage for the benefit of the Contractor.**

SC 15.01 Add the following new paragraph immediately after added Paragraph 15.01.B.5:

**6. The Application for Payment form to be used on this Project is EJCDC C-620 (latest edition). The Owner must approve all Applications for Payment before payment is made.**

SC 15.01 Delete Paragraph 15.01.C.1 in its entirety and replace with the following:

**1. Engineer will, within 14 days after receipt of each Application for Payment, including each submittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment.**

SC 15.01 Add the following new language immediately after 15.01.B.1:

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- a. **The Contractor shall be required to submit all pay estimates at the regularly scheduled construction meeting; no exceptions.**
  - I. **Prior to the approval of the first pay request, Contractor shall be responsible for providing the following to the Owner's and Engineer's satisfaction (no exceptions):**
    - 1) **Preconstruction Video**
    - 2) **Preconstruction Photos**
    - 3) **Project Schedule**
  - II. **All pay requests shall, at a minimum, accompany the following (no exceptions):**
    - 1) **Redline 11" x 17" As-Built Drawings**
    - 2) **Updated project progress schedule**
    - 3) **Project progress pictures**

SC 15.01 Delete Paragraph 15.01.D in its entirety and replace with the following:

1. **The Application for Payment with Engineer's recommendations will be presented to the Owner and Agency for consideration. If the Owner finds the Application for Payment acceptable, the recommended amount less any reduction under the provisions of Paragraph 15.01.E will become due thirty (30) days after the Application for Payment is presented to the Owner, and the Owner will make payment to the Contractor.**
2. **In the case that the Project is funded through an outside funding agency; due to approval and distribution process associated with the project, it is anticipated that the payment of the approved progress payment may take up to 60 days. Since the progress payment may exceed the time allowed for payment, as outlined in State of Florida Statute Chapter 218, Part VII, Governments Prompt Payment Act, Contractor at its own discretion may include interest in the mobilization bid items should the Contractor elect to enforce interest payment allowed per statute. There shall be no other interest payment to the Contractor except through the mobilization pay item if the payment is made within 60 days.**

SC 15.02 Amend Paragraph 15.02.A by striking out the following: "~~no later than seven days after the time of payment by Owner~~" and replace with:

**no later than the time of payment by Owner.**

SC 15.05 Delete Paragraph 15.05.A in its entirety and replace with the following:

- A. Final Inspection - Whenever the Engineer considers the Work provided and contemplated Contract is nearing completion, or within 10 days after being notified by the Contractor that the Work is completed, the Engineer**

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**will inspect all the Work included in the Contract. If the Engineer finds that the Work has not been satisfactorily completed at the time of such inspection, he shall advise the Contractor in writing as to the Work to be done or the particular defects to be remedied. When these defects have been remedied and the Work has been satisfactorily completed, the Engineer shall make the final inspection and shall notify the Contractor in writing that the Final Inspection has been made and that time charges end on the day of Final Inspection. Maintenance Period shall start on the day after this Final Inspection.**

- B. After the Final Inspection is made, the Contractor shall maintain the Work for 30 days in the same manner as set forth under “Maintenance of the Work During Construction”. The Work will finally be accepted at the end of the 30-day maintenance period provided all work has been satisfactorily maintained.**
- C. The Contractor, immediately after receiving the letter of Final Inspection, shall give notice of said completion of Work by an advertisement in some newspaper of general circulation published within the City or County wherein the Work has been done for a period of four successive weeks. Proof of publication of said notice shall be made by the Contractor to the Owner, by affidavit of the publisher and a printed copy of the notice published. If no newspaper is published in the County where Work is done, the notice may be given by posting at the Court House for 30 days and proof of same shall be made by probate judge or sheriff and the Contractor. In no instance shall a final settlement be made upon the Contract until the expiration of the Maintenance Period and until the Contract is completed and Project accepted by the Owner.**

END OF SECTION C-800

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**WORK CHANGE DIRECTIVE NO.:** \_\_\_\_\_

Owner:	City of Springfield	Owner's Project No.:	
Engineer:	Mott MacDonald	Engineer's Project No.:	502100062
Contractor:		Contractor's Project No.:	
Project:	Springfield City Complex – <i>(insert Civil/Site, Police Station, City Hall, Fire Station, Public Works)</i>		
Contract Name:			
Date Issued:		Effective Date of Work Change Directive:	

Contractor is directed to proceed promptly with the following change(s):

Description:

**[Description of the change to the Work]**

Attachments:

**[List documents related to the change to the Work]**

Purpose for the Work Change Directive:

**[Describe the purpose for the change to the Work]**

Directive to proceed promptly with the Work described herein, prior to agreeing to change in Contract Price and Contract Time, is issued due to:

**Notes to User—Check one or both of the following**

Non-agreement on pricing of proposed change.  Necessity to proceed for schedule or other reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price:	\$ _____	<b>[increase] [decrease] [not yet estimated].</b>
Contract Time:	_____ days	<b>[increase] [decrease] [not yet estimated].</b>

Basis of estimated change in Contract Price:

Lump Sum  Unit Price  Cost of the Work  Other

	Recommended by Engineer	Authorized by Owner
By:	_____	_____
Title:	_____	_____
Date:	_____	_____

**CHANGE ORDER NO.:** \_\_\_\_\_

Owner: City of Springfield  
 Engineer: Mott MacDonald  
 Contractor:  
 Project: Springfield City Complex – (insert Civil/Site, Police Station, City Hall, Fire Station, Public Works)  
 Contract Name:  
 Date Issued: Effective Date of Change Order:

The Contract is modified as follows upon execution of this Change Order:

Description:

**[Description of the change]**

Attachments:

**[List documents related to the change]**

Change in Contract Price	Change in Contract Times [State Contract Times as either a specific date or a number of days]
Original Contract Price: \$ _____	Original Contract Times: Substantial Completion: _____ Ready for final payment: _____
<b>[Increase] [Decrease]</b> from previously approved Change Orders No. 1 to No. <b>[Number of previous Change Order]</b> : \$ _____	<b>[Increase] [Decrease]</b> from previously approved Change Orders No.1 to No. <b>[Number of previous Change Order]</b> : Substantial Completion: _____ Ready for final payment: _____
Contract Price prior to this Change Order: \$ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for final payment: _____
<b>[Increase] [Decrease]</b> this Change Order: \$ _____	<b>[Increase] [Decrease]</b> this Change Order: Substantial Completion: _____ Ready for final payment: _____
Contract Price incorporating this Change Order: \$ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for final payment: _____

Recommended by Engineer (if required)

Accepted by Contractor

By: \_\_\_\_\_

\_\_\_\_\_

Title: \_\_\_\_\_

\_\_\_\_\_

Date: \_\_\_\_\_

\_\_\_\_\_

Authorized by Owner

Approved by Funding Agency (if applicable)

By: \_\_\_\_\_

\_\_\_\_\_

Title: \_\_\_\_\_

\_\_\_\_\_

Date: \_\_\_\_\_

\_\_\_\_\_





**FIELD ORDER NO.: [Number of Field Order]**

Owner: City of Springfield  
Engineer: Mott MacDonald  
Owner's Project No.:  
Engineer's Project No.: 502100062

Contractor: Contractor's Project No.:  
Project: Springfield City Complex – *(insert Civil/Site, Police Station, City Hall, Fire Station, Public Works)*  
Contract Name:  
Date Issued: Effective Date of Field Order:

Contractor is hereby directed to promptly perform the Work described in this Field Order, issued in accordance with Paragraph 11.04 of the General Conditions, for minor changes in the Work without changes in Contract Price or Contract Times. If Contractor considers that a change in Contract Price or Contract Times is required, submit a Change Proposal before proceeding with this Work.

**Reference:**

Specification Section(s):

Drawing(s) / Details (s):

**Description:**

**[Description of the change to the Work]**

**Attachments:**

**[List documents supporting change]**

**Issued by Engineer**

By: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

***DIVISION 1***  
***GENERAL REQUIREMENTS***

## SECTION 011000 - SUMMARY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work performed by Owner.
4. Owner-furnished/Contractor-installed (OFICI) products.
5. Owner-furnished/Owner-installed (OFOI) products.
6. Contractor's use of site and premises.
7. Work restrictions.
8. Specification and Drawing conventions.

- B. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
2. Section 01 73 00 "Execution" for coordination of Owner-installed products.

#### 1.3 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

#### 1.4 PROJECT INFORMATION

- A. Project Identification: **Springfield City Complex, City of Springfield**

Project Location: 1141 Transmitter Rd, Springfield, FL 32401

- B. Owner: City of Springfield

1. Owner's Representative: Mayor Ralph Hammond

- C. Architect: Mott MacDonald Florida LLC, 1022 West 23<sup>rd</sup> St, Panama City, FL 32405.

1. Architect's Representative: Andrew Marasca

- D. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:
1. Mechanical and Plumbing : Peterson Engineering, Inc.
    - a. Representatives: Greg Peterson P.E. Steve Johnson, P.E., Seth McGraw & Cindy Joiner, (850) 434-0513
  2. Electrical & Fire Alarm: Mott MacDonald Florida LLC
    - a. Representative: Andrew Gibbs, P.E., (850) 484-6011
  3. Landscape Architect: Tullo Planning Group
    - a. Representative: Gina Tullo-Williams, RLA, (850) 527-0653
  4. Structural Engineer: Mott MacDonald Florida LLC,
    - a. Representative: Chad Lyner, P.E. & Michael Tugwell, (850) 484-6011
  5. Civil Engineer: Mott MacDonald Florida LLC
    - a. Representatives: Tommy Pitts, Amir Zafar P.E. & Claude Elkins, (850) 763-9393

#### 1.5 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project, subject to editing pending final agreement on whether the City Complex and Community Center are under one or two contracts, is defined by the Contract Documents and includes, but is not limited to, the following:
1. **Springfield City Complex**, Springfield, Florida:  
In response to destruction of the City of Springfield facilities from Hurricane Michael in Fall 2018, the City of Springfield, with the assistance of FEMA, HUD, and additional grant funding sources, intends on building the following new facilities on a new site:
    - (1) **1141 Transmitter Road Site:**
      - New City Hall: 6,632 SF
      - New Police Department: 5,935 SF
      - New Fire Station: 11,191 SF
      - New Public Works Facility: 15,565 SF
      - Associated Civil/ Site/ Landscaping work

The construction duration for this project is **Five Hundred Forrrty (540) calendar days.**

2. and other Work indicated in the Contract Documents.
- B. Type of Contract:
1. Project will be constructed under two contracts, separate due to the different funding agencies, and both awarded to one successful Bidder.

1.6 WORK PERFORMED BY OWNER

- A. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before Work under this Contract begins.
  - 1. Landscape Clearing
- C. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory Work under this Contract.
  - 1. Information Technology Systems and Security System integration.

1.7 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFICI) PRODUCTS

- A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:
  - 1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
  - 2. Provide for delivery of Owner-furnished products to Project site.
  - 3. Upon delivery, inspect, with Contractor present, delivered items.
    - a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
  - 4. Obtain manufacturer's inspections, service, and warranties.
  - 5. Inform Contractor of earliest available delivery date for Owner-furnished products.
- B. Contractor's Responsibilities: The Work includes the following, as applicable:
  - 1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
  - 2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
  - 3. Receive, unload, handle, store, protect, and install Owner-furnished products.
  - 4. Make building services connections for Owner-furnished products.
  - 5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
  - 6. Repair or replace Owner-furnished products damaged following receipt.
- C. Owner-Furnished/Contractor-Installed (OFICI) Products:
  - 1. Electric generators.

1.8 OWNER-FURNISHED/OWNER-INSTALLED (OFOI) PRODUCTS

- A. The Owner will furnish and install products indicated.
- B. Owner-Furnished/Owner-Installed (OFOI) Products:
  - 1. Office Furniture.

1.9 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
  - 1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles always. Do not use these areas for parking or for storage of materials.
    - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Building: There are no existing buildings within the contract limits. There is a pole barn on the City's adjacent parcel to the north of the project site; the office trailer will be located under cover of the pole barn.
- D. Condition of Existing Grounds: The project site, previously operated as a plant nursery, has been cleared and there are very few remnants of the prior owner's operations.

1.10 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
  - 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 6:00 a.m. to 7:00 p.m., seven days per week, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner. Hours for **noisy activity**: 8:00 a.m. to 6:00 p.m.
- C. Existing Utility Interruptions: Obtain Owner's written permission before proceeding with any utility interruptions.
- D. Extreme Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption with Owner.

- E. Smoking and Controlled Substance Restrictions: Use of tobacco products is prohibited within buildings once they are “dried in”; **alcoholic beverages** and all controlled substances are prohibited on the Project Site.
- F. Contractor will abide by the rules and regulations of the Owner, (*City of Springfield*), concerning smoke areas, personnel behavior, inappropriate dress, and language, etc.
- G. Coordinate with authorities having jurisdiction and provide for any site-use environmental restrictions imposed by local, State, and/or County authorities having jurisdiction, where not indicated on the drawings.
  - 1. Protect adjacent public streets. Do not allow construction debris to enter adjacent storm sewers. Protect adjacent private drives, curbs and gutters, landscaping, and signage.
  - 2. Coordinate with Division 2 – Site Construction and civil drawings and provide for erosion control as required to prevent site storm water debris run off into county/city storm sewers or onto adjacent roads and highway. In particular note locations of “silt fence “barrier erosion control to protect adjacent properties, structures and existing storm water sewer inlets from construction site storm water drainage mud and debris.
  - 3. Protect adjacent property, and property owner from damages caused by work of this contract. Provide protective fencing as required at property line where same abuts Contractor’s site use area for manning project and storage of materials. Contractor is responsible for providing for protection of general public and adjacent property.
  - 4. Provide for disposal of waste material offsite, do not burn waste material or debris on site.

#### 1.11 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
  - 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
  - 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
  2. Abbreviations: Materials and products are identified by abbreviations [**scheduled on Drawings**] [**and**] [**published as part of the U.S. National CAD Standard**].
  3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.12 UTILIZATION OF MINORITY AND WOMEN FIRMS (M/WBE)

- A. The contractor shall take all necessary affirmative steps to assure that M/WBE firms are utilized when possible as suppliers and/or subcontractors, as applicable. Prior to contract award, the contractor shall document efforts to utilize M/WBE firms, including identifying what firms were solicited as suppliers and/or subcontractors, as applicable. Information regarding certified M/WBE firms can be obtained from:
1. Florida Department of Management Services, Office of Supplier Diversity
  2. Florida Department of Transportation (construction services, particularly highway),
  3. Minority Business Development Center in most major cities, and
  4. Local government M/WBE programs in many large counties and cities.
- B. A firm recognized as an M/WBE by any of the above agencies is acceptable for the CDBG program.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00



## SECTION 012200

### UNIT PRICE - MEASUREMENT AND PAYMENT

#### PART 1 – GENERAL

##### 1.01 GENERAL

- A. The unit price or lump sum bid items shall be compensation in full for furnishing all materials, labor, equipment, and incidentals necessary to complete the item in place in every detail in accordance with the plans and specifications. There will be no direct compensation for clean-up, restoration of property, and incidentals not shown in the proposal, and such incidentals shall be included in the unit price for the related item of work.

#### PART 2 – BID ITEMS

##### 2.01 CONTRACT #1: Civil Site Work – City Complex (Excluding and Excepting City Hall)

- A. The Civil Site Work (item no. 1 on the Bid Proposal Form) shall be compensation in full for mobilization; for furnishing all materials, labor, equipment, tools, and incidentals necessary for civil site work (excepting City Hall) as shown on the plans and specifications, including, but not limited to clearing and grubbing, grading and excavation, borrow material, compaction, storm drain components, utilities to within five feet of the footprints of the three buildings, pavement, curbing, signs, marking, exterior lighting, landscaping, fencing, and any incidental items necessary for the completion of all work shown on the drawings and in the specifications; and for all applicable overhead, profit, taxes, and project management cost.
  - 1. Excluded from this Contract #1 is any civil site, utilities, or any other improvements for the new City Hall planned for the City Complex site.
  - 2. See drawing Sheets G1.0, C1.2, C2.0, and C3.0 at the end of this Section 012200 for a delineation of the civil site improvements that are to be included in this Contract #1 from those to be included in Contract #2. All work outside the cloud shall be included in Contract #1 Civil Site Work and all work inside the cloud shall be included in Contract #2 City Hall.

##### 2.02 CONTRACT #2: City Hall, Fire Station, Police Station, and Public Works Building

- A. CITY HALL (item no. 2 on the Bid Proposal Form). The lump sum bid shall be compensation in full for mobilization; for furnishing all materials, labor, equipment, tools, and incidentals necessary for the construction of the City Hall building as shown on the plans and specifications to a point five feet beyond the building envelope; for the work related to the main power connection to the transformer and the work related to the emergency power connection to and set up of the generator; for all civil site, utilities, and any other improvements for the new City Hall that are excluded from Contract #1 in line 2.01.1 above; and for all applicable overhead, profit, taxes, and project management cost.
- B. POLICE STATION (item no. 3 on the Bid Proposal Form). The lump sum bid shall be compensation in full for mobilization; for furnishing all materials, labor, equipment, tools, and incidentals necessary for the construction of the Police Station building as shown on the plans and specifications to a point five feet beyond the building envelope; for the work related to the main power connection to the transformer and

## SECTION 012200

### UNIT PRICE - MEASUREMENT AND PAYMENT

the work related to the emergency power connection to and set up of the generator; and for all applicable overhead, profit, taxes, and project management cost.

- C. FIRE STATION (item no. 4 on the Bid Proposal Form). The lump sum bid shall be compensation in full for mobilization; for furnishing all materials, labor, equipment, tools, and incidentals necessary for the construction of the Fire Station building as shown on the plans and specifications to a point five feet beyond the building envelope; for the work related to the main power connection to the transformer and the work related to the emergency power connection to and set up of the generator; and for all applicable overhead, profit, taxes, and project management cost.
- D. PUBLIC WORKS BUILDING (item no. 5 on the Bid Proposal Form). The lump sum bid shall be compensation in full for mobilization; for furnishing all materials, labor, equipment, tools, and incidentals necessary for the construction of the Public Works building as shown on the plans and specifications to a point five feet beyond the building envelope; for the work related to the main power connection to the transformer and the work related to the emergency power connection to and set up of the generator; and for all applicable overhead, profit, taxes, and project management cost.

### PART 3 – ITEMS FOR ADDITIONS OR DELETIONS TO CIVIL SITE WORK BID

#### 3.01 WATER PIPE

- A. The unit price bid for the various sizes and types of water pipe shall be compensation in full for one linear foot of pipe complete in place. The length of pipe installed will be measured along the centerline of the installed pipe from center of installed pipe or junctions to center of junction or various ends with no deduction in measured length for specials, fittings, or valves.

#### 3.02 GATE VALVE

- A. The unit price bid for the various sizes and types of gate valves shall be compensation in full for furnishing all material, labor, equipment, tools, including valve, valve box, concrete pad and valve stem extension, if required and incidentals necessary to install and complete one valve in accordance with plans and specifications.

#### 3.03 MECHANICAL JOINT RETAINER GLANDS

- A. The unit price bid for this item shall be compensation in full for one (1) locked mechanical joint retainer gland of the various sizes complete in place including tee head bolts, set screws and gasket.

#### 3.04 FIRE HYDRANT ASSEMBLY

- A. The unit price bid shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals necessary to install and complete one fire hydrant

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assembly which includes, but not limited to, fire hydrant, anchoring tee, gate valve with concrete pad, valve box, fittings, piping, thrust restraints and any incidentals necessary for a complete installation as shown on the Drawings. Depth of bury shall be 36 inches (30-inch cover) except where shown otherwise on the plans or in the proposal.

3.05 DUCTILE IRON FITTINGS

- A. The unit price bid for the various sizes and types of fittings shall be compensation in full for furnishing all materials, labor, equipment, tools and incidental necessary to install and complete one pound of fittings. Payment will be based on catalog weight of the manufacturer supplying fittings. Bolts or other miscellaneous items will not be included in the weights.

3.06 PIPE FOR STACKS AND LATERALS

- A. The unit price bid for the various sizes, types, and depths of pipe used for stacks and laterals shall be compensation in full for one linear foot of pipe complete in place including plugs, caps, and bends. The length of pipe installed will be measured from center of sewer to the end of the lateral.
- B. Where laterals are to serve property that is lower than the street, the lateral shall be placed at such depth as required to serve such property and no additional payment will be made for the extra depth required.

3.07 CONCRETE

- A. The unit price bid shall be compensation in full for one cubic yard of concrete used for foundations, anchors, thrust blocks, encasement for pipe or concrete piers.

3.08 INLET

- A. The unit price bid shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals necessary to install and complete one inlet, of the various types and depths, per FDOT Standard Specification 425-1.

3.09 4' DIA. STORM DRAIN MANHOLE

- A. The unit price bid shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals necessary to install and complete one four-foot (4') diameter storm drain manhole, of the various depths, per FDOT Standard Specification 425-2.

3.10 15" RCP CL.III

- A. The unit price bid shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals necessary to install and complete one linear foot of 15" diameter reinforced concrete pipe, class III, per FDOT Standard Specification 430-1.

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3.11 18" RCP CL.III

- A. The unit price bid shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals necessary to install and complete one linear foot of 18" diameter reinforced concrete pipe, class III, per FDOT Standard Specification 430-1.

3.12 24" RCP CL. III

- A. The unit price bid shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals necessary to install and complete one linear foot of 24" diameter reinforced concrete pipe, class III, per FDOT Standard Specification 430-1.

END OF SECTION 012200

## SECTION 012500 - SUBSTITUTION PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
  - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

#### 1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
  - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

#### 1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use CSI Form 13.1A.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
    - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size,

- durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. Certificates and qualification data, where applicable or requested.
  - g. List of similar installations for completed projects with project names and addresses and names and addresses of Engineer/Architects and owners.
  - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - i. Research reports evidencing compliance with building code in effect for Project, from applicable code organization.
  - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - k. Cost information, including a proposal of change, if any, in the Contract Sum.
  - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
  - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Engineer/Architect's Action: If necessary, Engineer/Architect or Program Manager will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer/Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer/Architect's Supplemental Instructions for minor changes in the Work.
  - b. Use product specified if Engineer/Architect does not issue a decision on use of a proposed substitution within time allocated.

#### 1.4 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

## 1.5 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

## PART 2 - PRODUCTS

### 2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
  - 1. Conditions: Engineer/Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - b. Requested substitution provides sustainable design characteristics that specified product provided for achieving LEED prerequisites and credits.
    - c. Substitution request is fully documented and properly submitted.
    - d. Requested substitution will not adversely affect Contractor's construction schedule.
    - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - f. Requested substitution is compatible with other portions of the Work.
    - g. Requested substitution has been coordinated with other portions of the Work.
    - h. Requested substitution provides specified warranty.
    - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not allowed unless otherwise indicated.
- C. Substitutions for Convenience: Engineer/Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer/Architect.
  - 1. Conditions: Engineer/Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities

Owner must assume. Owner's additional responsibilities may include compensation to Engineer/Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

- b. Requested substitution does not require extensive revisions to the Contract Documents.
- c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- d. Requested substitution provides sustainable design characteristics that specified product provided for achieving LEED prerequisites and credits.
- e. Substitution request is fully documented and properly submitted.
- f. Requested substitution will not adversely affect Contractor's construction schedule.
- g. Requested substitution has received necessary approvals of authorities having jurisdiction.
- h. Requested substitution is compatible with other portions of the Work.
- i. Requested substitution has been coordinated with other portions of the Work.
- j. Requested substitution provides specified warranty.
- k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500



## SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
  - 1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

#### 1.3 MINOR CHANGES IN THE WORK

- A. Engineer/Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on **EJCDC C-942 Field Order**.

#### 1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: **Engineer/Architect** will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Work Change Proposal Requests issued by **Engineer/Architect** are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within **time specified in Proposal Request or 20 days, when not otherwise specified**, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.
    - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and

finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

- e. Quotation Form: Use **forms acceptable to Engineer/Architect**.

- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to **Engineer/Architect**.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use **form acceptable to Engineer/Architect**.

#### 1.5 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. Unit-Price Adjustment: See Section 012200 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

#### 1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, **Engineer/Architect** will issue a Change Order for signatures of Owner and Contractor on **EJCDC C-941**.

#### 1.7 WORK CHANGE DIRECTIVE

- A. Work Change Directive: [**Engineer/Architect**] may issue a Work Change Directive on **EJCDC C-940**. Work Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
  1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

## SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
  - 1. General coordination procedures.
  - 2. RFIs.
  - 3. Digital project management procedures.
  - 4. Project meetings.
- B. Related Requirements:
  - 1. Section 013230 "Network Analysis Schedule" for preparing and submitting Contractor's construction schedule.
  - 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
  - 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

#### 1.3 DEFINITIONS

- A. RFI: Request for Information. Request from Owner, Engineer, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
  - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
  - 2. Number and title of related Specification Section(s) covered by subcontract.
  - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within **15** days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone

numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and in prominent location in built facility. Keep list current at all times.

#### 1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
  1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
  2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
  3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
  1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

#### 1.6 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  1. Engineer/Architect will return without response those RFIs submitted to Engineer/Architect by other entities controlled by Contractor.
  2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  1. Project name.
  2. Owner name.
  3. Owner's Project number.
  4. Name of Engineer/Architect.
  5. Engineer/Architect's Project number.
  6. Date.
  7. Name of Contractor.
  8. RFI number, numbered sequentially.

9. RFI subject.
  10. Specification Section number and title and related paragraphs, as appropriate.
  11. Drawing number and detail references, as appropriate.
  12. Field dimensions and conditions, as appropriate.
  13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  14. Contractor's signature.
  15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: **Software-generated form with substantially the same content as indicated above, acceptable to Engineer/Architect.**
1. Attachments shall be electronic files in PDF format.
- D. Engineer's/Architect's Action: Engineer/Architect will review each RFI, determine action required, and respond. Allow **[seven]** days for Engineer's/Architect's response for each RFI. RFIs received by Engineer/Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.
    - f. Requests for interpretation of Engineer/Architect's actions on submittals.
    - g. Incomplete RFIs or inaccurately prepared RFIs.
  2. Engineer's/Architect's action may include a request for additional information, in which case Engineer's/Architect's time for response will date from time of receipt by Engineer/Architect of additional information.
  3. Engineer's/Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
    - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer/Architect in writing within **[5]** days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log **[monthly]**. **[Include the following:]**
1. Project name.
  2. Name and address of Contractor.

3. Name and address of Engineer/Architect.
  4. RFI number, including RFIs that were returned without action or withdrawn.
  5. RFI description.
  6. Date the RFI was submitted.
  7. Date Engineer's/Architect's response was received.
  8. Identification of related Minor Change in the Work, Work Change Directive, and Proposal Request, as appropriate.
  9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Engineer's/Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer/Architect within [**three**] days if Contractor disagrees with response.

#### 1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Engineer's/Architect's Digital Data Files: Digital data files of Engineer's/Architect's **AutoCAD drawings** will be provided by Engineer/Architect for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
  2. Engineer/Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
  3. Digital Drawing Software Program: Contract Drawings are available in **<AutoCAD 2018>**.
  4. Contractor shall execute a data licensing agreement in the form of **Agreement form acceptable to Owner and Engineer/Architect**.
    - a. Subcontractors and other parties granted access by Contractor to Engineer's/Architect's digital data files shall execute a data licensing agreement in the form of **Agreement acceptable to Owner and Engineer/Architect**.
  5. The following digital data files will be furnished for each appropriate discipline:
    - a. Floor plans.
    - b. Reflected ceiling plans.
    - c. Civil plans.
- B. PDF Document Preparation: Where PDFs are required to be submitted to Engineer/Architect, prepare as follows:
1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
    - a. Engineer's/Architect's **AutoCAD drawings** may not be used in the creation or submittal of shop drawings.
  2. Name file with submittal number or other unique identifier, including revision identifier.
  3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

## 1.8 PROJECT MEETINGS

- A. General: **Engineer/Architect will schedule and conduct** meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer/Architect of scheduled meeting dates and times a minimum of **seven** days prior to meeting.
  2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, and Engineer/Architect, within **three** days of the meeting.
- B. Preconstruction Conference: **Engineer/Architect will schedule and conduct** a preconstruction conference before starting construction, at a time convenient to Owner and Engineer/Architect, but no later than **10** days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner, Engineer/Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Responsibilities and personnel assignments.
    - b. Tentative construction schedule.
    - c. Phasing.
    - d. Critical work sequencing and long lead items.
    - e. Designation of key personnel and their duties.
    - f. Lines of communications.
    - g. Use of web-based Project software.
    - h. Procedures for processing field decisions and Change Orders.
    - i. Procedures for RFIs.
    - j. Procedures for testing and inspecting.
    - k. Procedures for processing Applications for Payment.
    - l. Distribution of the Contract Documents.
    - m. Submittal procedures.
    - n. Preparation of Record Documents.
    - o. Use of the premises
    - p. Work restrictions.
    - q. Working hours.
    - r. Owner's occupancy requirements.
    - s. Responsibility for temporary facilities and controls.
    - t. Procedures for moisture and mold control.
    - u. Procedures for disruptions and shutdowns.
    - v. Construction waste management and recycling.
    - w. Parking availability.
    - x. Office, work, and storage areas.
    - y. Equipment deliveries and priorities.
    - z. First aid.
    - aa. Security.
    - bb. Progress cleaning.



3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer/Architect, of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    - a. Contract Documents.
    - b. Options.
    - c. Related RFIs.
    - d. Related Change Orders.
    - e. Purchases.
    - f. Deliveries.
    - g. Submittals.
    - h. Review of mockups.
    - i. Possible conflicts.
    - j. Compatibility requirements.
    - k. Time schedules.
    - l. Weather limitations.
    - m. Manufacturer's written instructions.
    - n. Warranty requirements.
    - o. Compatibility of materials.
    - p. Acceptability of substrates.
    - q. Temporary facilities and controls.
    - r. Space and access limitations.
    - s. Regulations of authorities having jurisdiction.
    - t. Testing and inspecting requirements.
    - u. Installation procedures.
    - v. Coordination with other work.
    - w. Required performance results.
    - x. Protection of adjacent work.
    - y. Protection of construction and personnel.
  3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
  5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: **Engineer/Architect will Schedule and conduct** a project closeout conference, at a time convenient to Owner and Engineer/Architect, but no later than **30** days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
  2. Attendees: Authorized representatives of Owner, Engineer/Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
    - a. Preparation of Record Documents.
    - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
    - c. Procedures for completing and archiving web-based Project software site data files.
    - d. Submittal of written warranties.
    - e. Requirements for preparing operations and maintenance data.
    - f. Requirements for delivery of material samples, attic stock, and spare parts.
    - g. Requirements for demonstration and training.
    - h. Preparation of Contractor's punch list.
    - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
    - j. Submittal procedures.
    - k. Owner's partial occupancy requirements.
    - l. Installation of Owner's furniture, fixtures, and equipment.
    - m. Responsibility for removing temporary facilities and controls.
  4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: **Engineer/Architect will Conduct** progress meetings , depending on Project progress or criticality, frequency can vary from weekly, bi-weekly or monthly and will be determined by Engineer at their own discretion intervals.
1. Coordinate dates of meetings with preparation of payment requests.
  2. Attendees: In addition to representatives of Owner and Engineer/Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 1) Review schedule for next period.

- b. Review present and future needs of each entity present, including the following:
  - 1) Interface requirements.
  - 2) Sequence of operations.
  - 3) Status of submittals.
  - 4) Deliveries.
  - 5) Off-site fabrication.
  - 6) Access.
  - 7) Site use.
  - 8) Temporary facilities and controls.
  - 9) Progress cleaning.
  - 10) Quality and work standards.
  - 11) Status of correction of deficient items.
  - 12) Field observations.
  - 13) Status of RFIs.
  - 14) Status of Proposal Requests.
  - 15) Pending changes.
  - 16) Status of Change Orders.
  - 17) Pending claims and disputes.
  - 18) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
  - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

## SECTION 01 32 30 - NETWORK ANALYSIS SCHEDULES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. References.
- B. Quality assurance.
- C. Format.
- D. Schedules.
- E. Submittals.
- F. Review and evaluation.
- G. Updating schedules.
- H. Distribution.

#### 1.2 REFERENCES

- A. The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry, Washington, D.C., The Associated General Contractors of America (AGC).
- B. CPM in Construction Management - Project Management with CPM, O'Brien, McGraw-Hill Book Company, New York.

#### 1.3 QUALITY ASSURANCE

- A. Scheduler: Contractor's personnel specializing in CPM scheduling with two years minimum experience in scheduling construction work of complexity comparable to this Project and having use of computer facilities capable of delivering detailed graphic printout.
- B. Contractor's Administrative Personnel: Five years minimum experience in using and monitoring CPM schedules on comparable projects.

#### 1.4 FORMAT

- A. Listings: Reading from left to right, in ascending order for each activity. Identify each activity with applicable specification section number.
- B. Diagram Sheet Size: 24 inches high x 36 inches wide.

- C. Scale and Spacing: To allow for notations and revisions.

## 1.5 SCHEDULES

- A. Prepare network analysis diagrams and supporting mathematical analyses using Critical Path Method, under concepts and methods outlined in AGC's "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".
- B. Illustrate order and interdependence of activities and sequence of work; how start of given activity depends on completion of preceding activities, and how completion of activity may restrain start of subsequent activities.
- C. Illustrate complete sequence of construction by activity, identifying work of separate stages. floors. Indicate dates for submittals including dates for Owner furnished items and return of submittals; dates for procurement and delivery of critical products; and dates for installation and provision for testing. Include legend for symbols and abbreviations used.
- D. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
1. Preceding and following event numbers.
  2. Activity description.
  3. Estimated duration of activity, in maximum 15-day intervals.
  4. Earliest start date.
  5. Earliest finish date.
  6. Actual start date.
  7. Actual finish date.
  8. Latest start date.
  9. Latest finish date.
  10. Total and free float; accrue float time to Owner and to Owner's benefit.
  11. Monetary value of activity, keyed to Schedule of Values.
  12. Percentage of activity completed.
  13. Responsibility.
- E. Analysis Program: Capable of compiling monetary value of completed and partially completed activities, of accepting revised completion dates, and computation of scheduled dates and float.
- F. Required Sorts: List activities in sorts or groups:
1. By preceding work item or event number from lowest to highest.
  2. By longest float, then in order of early start.
  3. By responsibility in order of earliest possible start date.
  4. In order of latest allowable start dates.
  5. In order of latest allowable finish dates.
  6. Contractor's periodic payment request sorted by Schedule of Values listings specifications sections.
  7. Listing of basic input data generating report.
  8. Listing of activities on critical path.

G. Prepare sub-schedules for each stage of Work identified in Section 01100.

H. Coordinate contents with schedule of values in Section 01330.

#### 1.6 SUBMITTALS

A. Within 10 days after date of Owner-Contractor Agreement, submit proposed preliminary network diagram defining planned operations for first 60 days of Work, with general outline for remainder of Work.

B. Participate in review of preliminary and complete network diagrams jointly with Architect/Engineer.

C. Within 20 days after joint review of proposed preliminary network diagram, submit draft of proposed complete network diagram for review. Include written certification that major Subcontractors have reviewed and accepted proposed schedule.

D. Within 10 days after joint review, submit complete network analysis consisting of network diagrams and mathematical analysis.

E. Submit updated network schedules with each Application for Payment.

F. Submit number of opaque reproductions Contractor requires, plus two copies Architect/Engineer will retain.

G. Submit under transmittal letter form specified in Section 01330.

#### 1.7 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of network diagrams and analysis with Architect/Engineer at each submittal.

B. Evaluate project status to determine work behind schedule and work ahead of schedule.

C. After review, revise network diagrams and analysis incorporating results of review, and resubmit within 10 days.

#### 1.8 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update diagrams to graphically depict current status of Work.

C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

D. Indicate changes required to maintain Date of Substantial Completion.

- E. Submit sorts required to support recommended changes.
- F. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect including effects of changes on schedules of separate contractors.

1.9 DISTRIBUTION

- A. Following joint review, distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, and Engineer/Architect.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION 01 32 30

## SECTION 01 33 00 - SUBMITTAL PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Submittal schedule requirements.
- 2. Administrative and procedural requirements for submittals.

- B. Related Requirements:

- 1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
- 2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
- 3. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
- 4. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
- 5. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
- 6. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
- 7. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

#### 1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's/Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's/Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."



#### 1.4 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer/Architect and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
  2. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
    - a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
  3. Format: Arrange the following information in a tabular format:
    - a. Scheduled date for first submittal.
    - b. Specification Section number and title.
    - c. Submittal Category: Action; informational.
    - d. Name of subcontractor.
    - e. Description of the Work covered.
    - f. Scheduled date for Engineer/Architect's final release or approval.
    - g. Scheduled dates for purchasing.
    - h. Scheduled date of fabrication.
    - i. Scheduled dates for installation.
    - j. Activity or event number.

#### 1.5 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
1. Project name.
  2. Date.
  3. Name of Engineer/Architect.
  4. Name of Contractor.
  5. Name of firm or entity that prepared submittal.
  6. Names of subcontractor, manufacturer, and supplier.
  7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
  8. Category and type of submittal.
  9. Submittal purpose and description.
  10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
  11. Drawing number and detail references, as appropriate.
  12. Indication of full or partial submittal.
  13. Location(s) where product is to be installed, as appropriate.
  14. Other necessary identification.

15. Remarks.
16. Signature of transmitter.

- B. Options: Identify options requiring selection by Engineer/Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer/Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

## 1.6 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
  1. Email: Prepare submittals as PDF package and transmit to Engineer/Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Engineer/Architect.
    - a. Engineer/Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. [Engineer/Architect reserves] the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on [Engineer's/Architect's] receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
  1. Initial Review: Allow <10> days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. [Engineer/Architect] will advise Contractor when a submittal being processed must be delayed for coordination.

2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow <7> days for review of each resubmittal.
  4. Sequential Review: Where sequential review of submittals by Engineer's/Architect's consultants, Owner, or other parties is indicated, allow <15> days for initial review of each submittal.
  5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Engineer/Architect and to Engineer's/Architect's consultants, allow **15** days for review of each submittal. Submittal will be returned to **Engineer/Architect** before being returned to Contractor.
    - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer/Architect.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
  2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
  3. Resubmit submittals until they are marked with approval notation from Engineer's/Architect's action stamp.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's/Architect's action stamp.

## 1.7 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.
  3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:

- a. Wiring diagrams that show factory-installed wiring.
  - b. Printed performance curves.
  - c. Operational range diagrams.
  - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data **unless submittal based on Engineer's/Architect's digital data drawing files is otherwise permitted.**
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
- C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
  2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
    - a. Project name and submittal number.
    - b. Generic description of Sample.
    - c. Product name and name of manufacturer.
    - d. Sample source.
    - e. Number and title of applicable Specification Section.
    - f. Specification paragraph number and generic name of each item.
  3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics and identification information for record.
  4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.
  - a. Applicability: If colors and other characteristics are **not** preselected and specified or scheduled.
  - b. Number of Samples: Submit [**one**] full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer/Architect will return submittal with options selected.
6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  - a. Number of Samples: Submit **two** sets of Samples. Engineer/Architect will retain **one** Sample sets; remainder will be returned. **Mark up and retain one returned Sample set as a project record Sample.**
    - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
    - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least [**three**] sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
  1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
  2. Manufacturer and product name, and model number if applicable.
  3. Number and name of room or space.
  4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineer/architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - a. Name of evaluation organization.
  - b. Date of evaluation.
  - c. Time period when report is in effect.
  - d. Product and manufacturers' names.
  - e. Description of product.
  - f. Test procedures and results.
  - g. Limitations of use.

## 1.8 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Engineer/Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit [**digitally signed PDF file**] [**and**] [**three**] paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

## 1.9 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer/Architect.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with [**a uniform approval stamp**]. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
  - 1. Engineer/Engineer/Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

## 1.10 ENGINEER'S/ARCHITECT'S REVIEW

- A. Action Submittals: Engineer/Architect will review each submittal, indicate corrections or revisions required, [**and return**].
  - 1. PDF Submittals: Engineer/Architect will indicate, via markup on each submittal, the appropriate action.
- B. Informational Submittals: Engineer/Architect will review each submittal and will not return it or will return it if it does not comply with requirements. Engineer/Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer/Architect.

- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Engineer/Architect will **return without review** submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned by Engineer/Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 33 00



## SECTION 01 40 00 - QUALITY REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
  - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
  - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer/Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Requirements:
  - 1. Section 012100 "Allowances" for testing and inspection allowances.

#### 1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of **five** previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
1. Mockups are used for one or more of the following:
    - a. Verify selections made under Sample submittals.
    - b. Demonstrate aesthetic effects.
    - c. Demonstrate the qualities of products and workmanship.
    - d. Demonstrate successful installation of interfaces between components and systems.
    - e. Perform preconstruction testing to determine system performance.
  2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
  3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer/Architect.

#### 1.4 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer/Architect.
- B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

#### 1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Engineer/Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Engineer/Architect for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer/Architect for a decision before proceeding.

#### 1.6 ACTION SUBMITTALS

- A. Mockup Shop Drawings:
  - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
  - 2. Indicate manufacturer and model number of individual components.
  - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.

- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
  - 1. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
  - 1. Specification Section number and title.
  - 2. Entity responsible for performing tests and inspections.
  - 3. Description of test and inspection.
  - 4. Identification of applicable standards.
  - 5. Identification of test and inspection methods.
  - 6. Number of tests and inspections required.
  - 7. Time schedule or time span for tests and inspections.
  - 8. Requirements for obtaining samples.
  - 9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

#### 1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within **10** days of **Notice to Proceed**, and not less than **five** days prior to preconstruction conference. Submit in format acceptable to Engineer/Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
  2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
  3. Owner-performed tests and inspections indicated in the Contract Documents.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Engineer/Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

#### 1.9 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
  2. Project title and number.
  3. Name, address, telephone number, and email address of testing agency.
  4. Dates and locations of samples and tests or inspections.
  5. Names of individuals making tests and inspections.
  6. Description of the Work and test and inspection method.
  7. Identification of product and Specification Section.
  8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
  2. Statement on condition of substrates and their acceptability for installation of product.
  3. Statement that products at Project site comply with requirements.
  4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.

5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  6. Statement of whether conditions, products, and installation will affect warranty.
  7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
  2. Statement that equipment complies with requirements.
  3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  4. Statement of whether conditions, products, and installation will affect warranty.
  5. Other required items indicated in individual Specification Sections.

#### 1.10 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as

documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following Contractor's responsibilities, including the following:
  - 1. Provide test specimens representative of proposed products and construction.
  - 2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
  - 3. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
  - 4. When testing is complete, remove test specimens and test assemblies, **[and]** mockups; do not reuse products on Project.
  - 5. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer/Architect, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
- K. **Mockups:** Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
  - 1. Build mockups of size indicated.
  - 2. Build mockups in location indicated or, if not indicated, as directed by Engineer/Architect.
  - 3. Notify Engineer/Architect **[seven]** days in advance of dates and times when mockups will be constructed.
  - 4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
  - 5. Demonstrate the proposed range of aesthetic effects and workmanship.
  - 6. Obtain Engineer/Architect's approval of mockups before starting corresponding Work, fabrication, or construction.
    - a. Allow **seven** days for initial review and each re-review of each mockup.
  - 7. Promptly correct unsatisfactory conditions noted by Engineer/Architect's preliminary review, to the satisfaction of the Engineer/Architect, before completion of final mockup.

8. Approval of mockups by the Engineer/Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer/Architect specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
10. Demolish and remove mockups when directed unless otherwise indicated.

#### 1.11 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
  1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
  2. Payment for these services will be made from testing and inspection allowances specified in Section 012100 "Allowances," as authorized by Change Orders.
  3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, **and the Contract Sum will be adjusted by Change Order.**
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
  1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  2. Engage a qualified testing agency to perform quality-control services.
    - a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  3. Notify testing agencies at least **24** hours in advance of time when Work that requires testing or inspection will be performed.
  4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Engineer/Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.



1. Notify Engineer/Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
  4. Facilities for storage and field curing of test samples.
  5. Delivery of samples to testing agencies.
  6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents [**as a component of Contractor's quality-control plan**]. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.

1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to Owner, Engineer/Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

#### 1.12 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Contractor will engage a qualified [**testing agency**] [**special inspector**] to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
  2. Notifying Engineer/Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer/Architect with copy to Contractor and to authorities having jurisdiction.
  4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
  5. Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
  6. Retesting and reinspecting corrected Work.

#### PART 2 - PRODUCTS (Not Used)

#### PART 3 - EXECUTION

##### 3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
  2. Description of the Work tested or inspected.
  3. Date test or inspection results were transmitted to Engineer/Architect.
  4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer/Architect's **and** Owner reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.
  - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

## SECTION 014200 - REFERENCES

### PART 1 - GENERAL

#### 1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Engineer/Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer/Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Engineer/Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

#### 1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents

unless otherwise indicated.

- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
  - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

### 1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AABC	Associated Air Balance Council <a href="http://www.aabc.com">www.aabc.com</a>
AAMA	American Architectural Manufacturers Association <a href="http://www.aamanet.org">www.aamanet.org</a>
AASHTO	American Association of State Highway and Transportation Officials <a href="http://www.transportation.org">www.transportation.org</a>
AATCC	American Association of Textile Chemists and Colorists <a href="http://www.aatcc.org">www.aatcc.org</a>
ABMA	American Bearing Manufacturers Association <a href="http://www.americanbearings.org">www.americanbearings.org</a>
ACI	American Concrete Institute (Formerly: ACI International) <a href="http://www.concrete.org">www.concrete.org</a>
ACPA	American Concrete Pipe Association <a href="http://www.concrete-pipe.org">www.concrete-pipe.org</a>
AEIC	Association of Edison Illuminating Companies, Inc. (The) <a href="http://www.aeic.org">www.aeic.org</a>
AF&PA	American Forest & Paper Association <a href="http://www.afandpa.org">www.afandpa.org</a>
AGA	American Gas Association <a href="http://www.aga.org">www.aga.org</a>

AHAM	Association of Home Appliance Manufacturers <a href="http://www.aham.org">www.aham.org</a>
AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The) <a href="http://www.ahrinet.org">www.ahrinet.org</a>
AI	Asphalt Institute <a href="http://www.asphaltinstitute.org">www.asphaltinstitute.org</a>
AIA	American Institute of Architects (The) <a href="http://www.aia.org">www.aia.org</a>
AISC	American Institute of Steel Construction <a href="http://www.aisc.org">www.aisc.org</a>
AISI	American Iron and Steel Institute <a href="http://www.steel.org">www.steel.org</a>
AITC	American Institute of Timber Construction <a href="http://www.aitc-glulam.org">www.aitc-glulam.org</a>
AMCA	Air Movement and Control Association International, Inc. <a href="http://www.amca.org">www.amca.org</a>
ANSI	American National Standards Institute <a href="http://www.ansi.org">www.ansi.org</a>
AOSA	Association of Official Seed Analysts, Inc. <a href="http://www.aosaseed.com">www.aosaseed.com</a>
APA	APA - The Engineered Wood Association <a href="http://www.apawood.org">www.apawood.org</a>
APA	Architectural Precast Association <a href="http://www.archprecast.org">www.archprecast.org</a>
API	American Petroleum Institute <a href="http://www.api.org">www.api.org</a>
ARI	Air-Conditioning & Refrigeration Institute (See AHRI)
ARI	American Refrigeration Institute (See AHRI)
ARMA	Asphalt Roofing Manufacturers Association <a href="http://www.asphaltroofing.org">www.asphaltroofing.org</a>

ASCE	American Society of Civil Engineers <a href="http://www.asce.org">www.asce.org</a>
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers <a href="http://www.ashrae.org">www.ashrae.org</a>
ASME	ASME International (American Society of Mechanical Engineers) <a href="http://www.asme.org">www.asme.org</a>
ASSE	American Society of Safety Engineers (The) <a href="http://www.asse.org">www.asse.org</a>
ASSE	American Society of Sanitary Engineering <a href="http://www.asse-plumbing.org">www.asse-plumbing.org</a>
ASTM	ASTM International (American Society for Testing and Materials International) <a href="http://www.astm.org">www.astm.org</a>
ATIS	Alliance for Telecommunications Industry Solutions <a href="http://www.atis.org">www.atis.org</a>
AWEA	American Wind Energy Association <a href="http://www.awea.org">www.awea.org</a>
AWI	Architectural Woodwork Institute <a href="http://www.awinet.org">www.awinet.org</a>
AWMAC	Architectural Woodwork Manufacturers Association of Canada <a href="http://www.awmac.com">www.awmac.com</a>
AWPA	American Wood Protection Association (Formerly: American Wood-Preservers' Association) <a href="http://www.awpa.com">www.awpa.com</a>
AWS	American Welding Society <a href="http://www.aws.org">www.aws.org</a>
AWWA	American Water Works Association

	<a href="http://www.awwa.org">www.awwa.org</a>
BHMA	Builders Hardware Manufacturers Association <a href="http://www.buildershardware.com">www.buildershardware.com</a>
BIA	Brick Industry Association (The) <a href="http://www.gobrick.com">www.gobrick.com</a>
BICSI	BICSI, Inc. <a href="http://www.bicsi.org">www.bicsi.org</a>
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association) <a href="http://www.bifma.com">www.bifma.com</a>
BISSC	Baking Industry Sanitation Standards Committee <a href="http://www.bissc.org">www.bissc.org</a>
BOCA	BOCA (Building Officials and Code Administrators International Inc.) (See ICC)
BWF	Badminton World Federation (Formerly: International Badminton Federation) <a href="http://www.bwfbadminton.org">www.bwfbadminton.org</a>
CDA	Copper Development Association <a href="http://www.copper.org">www.copper.org</a>
CEA	Canadian Electricity Association <a href="http://www.electricity.ca">www.electricity.ca</a>
CEA	Consumer Electronics Association <a href="http://www.ce.org">www.ce.org</a>
CFFA	Chemical Fabrics & Film Association, Inc. <a href="http://www.chemicalfabricsandfilm.com">www.chemicalfabricsandfilm.com</a>
CFSEI	Cold-Formed Steel Engineers Institute <a href="http://www.cfsei.org">www.cfsei.org</a>
CGA	Compressed Gas Association <a href="http://www.cganet.com">www.cganet.com</a>
CIMA	Cellulose Insulation Manufacturers Association



	<a href="http://www.cellulose.org">www.cellulose.org</a>
CISCA	Ceilings & Interior Systems Construction Association <a href="http://www.cisca.org">www.cisca.org</a>
CISPI	Cast Iron Soil Pipe Institute <a href="http://www.cispi.org">www.cispi.org</a>
CLFMI	Chain Link Fence Manufacturers Institute <a href="http://www.chainlinkinfo.org">www.chainlinkinfo.org</a>
CPA	Composite Panel Association <a href="http://www.pbmdf.com">www.pbmdf.com</a>
CRI	Carpet and Rug Institute (The) <a href="http://www.carpet-rug.org">www.carpet-rug.org</a>
CRRC	Cool Roof Rating Council <a href="http://www.coolroofs.org">www.coolroofs.org</a>
CRSI	Concrete Reinforcing Steel Institute <a href="http://www.crsi.org">www.crsi.org</a>
CSA	Canadian Standards Association <a href="http://www.csa.ca">www.csa.ca</a>
CSA	CSA International (Formerly: IAS - International Approval Services) <a href="http://www.csa-international.org">www.csa-international.org</a>
CSI	Construction Specifications Institute (The) <a href="http://www.csinet.org">www.csinet.org</a>
CSSB	Cedar Shake & Shingle Bureau <a href="http://www.cedarbureau.org">www.cedarbureau.org</a>
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) <a href="http://www.cti.org">www.cti.org</a>
CWC	Composite Wood Council (See CPA)
DASMA	Door and Access Systems Manufacturers Association <a href="http://www.dasma.com">www.dasma.com</a>
DHI	Door and Hardware Institute

	<a href="http://www.dhi.org">www.dhi.org</a>
ECA	Electronic Components Association <a href="http://www.ec-central.org">www.ec-central.org</a>
ECAMA	Electronic Components Assemblies & Materials Association (See ECA)
EIA	Electronic Industries Alliance (See TIA)
EIMA	EIFS Industry Members Association <a href="http://www.eima.com">www.eima.com</a>
EJMA	Expansion Joint Manufacturers Association, Inc. <a href="http://www.ejma.org">www.ejma.org</a>
ESD	ESD Association (Electrostatic Discharge Association) <a href="http://www.esda.org">www.esda.org</a>
ESTA	Entertainment Services and Technology Association (See PLASA)
EVO	Efficiency Valuation Organization <a href="http://www.evo-world.org">www.evo-world.org</a>
FIBA	Fédération Internationale de Basketball (The International Basketball Federation) <a href="http://www.fiba.com">www.fiba.com</a>
FIVB	Fédération Internationale de Volleyball (The International Volleyball Federation) <a href="http://www.fivb.org">www.fivb.org</a>
FM Approvals	FM Approvals LLC <a href="http://www.fmglobal.com">www.fmglobal.com</a>
FM Global	FM Global (Formerly: FMG - FM Global) <a href="http://www.fmglobal.com">www.fmglobal.com</a>
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. <a href="http://www.floridarroof.com">www.floridarroof.com</a>
FSA	Fluid Sealing Association

	<a href="http://www.fluidsealing.com">www.fluidsealing.com</a>
FSC	Forest Stewardship Council U.S. <a href="http://www.fscus.org">www.fscus.org</a>
GA	Gypsum Association <a href="http://www.gypsum.org">www.gypsum.org</a>
GANA	Glass Association of North America <a href="http://www.glasswebsite.com">www.glasswebsite.com</a>
GS	Green Seal <a href="http://www.greenseal.org">www.greenseal.org</a>
HI	Hydraulic Institute <a href="http://www.pumps.org">www.pumps.org</a>
HI/GAMA	Hydronics Institute/Gas Appliance Manufacturers Association (See AHRI)
HMMA	Hollow Metal Manufacturers Association (See NAAMM)
HPVA	Hardwood Plywood & Veneer Association <a href="http://www.hpva.org">www.hpva.org</a>
HPW	H. P. White Laboratory, Inc. <a href="http://www.hpwhite.com">www.hpwhite.com</a>
IAPSC	International Association of Professional Security Consultants <a href="http://www.iapsc.org">www.iapsc.org</a>
IAS	International Approval Services (See CSA)
ICBO	International Conference of Building Officials (See ICC)
ICC	International Code Council <a href="http://www.iccsafe.org">www.iccsafe.org</a>
ICEA	Insulated Cable Engineers Association, Inc. <a href="http://www.icea.net">www.icea.net</a>
ICPA	International Cast Polymer Alliance <a href="http://www.icpa-hq.org">www.icpa-hq.org</a>

ICRI	International Concrete Repair Institute, Inc. <a href="http://www.icri.org">www.icri.org</a>
IEC	International Electrotechnical Commission <a href="http://www.iec.ch">www.iec.ch</a>
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) <a href="http://www.ieee.org">www.ieee.org</a>
IES	Illuminating Engineering Society (Formerly: Illuminating Engineering Society of North America) <a href="http://www.ies.org">www.ies.org</a>
IESNA	Illuminating Engineering Society of North America (See IES)
IEST	Institute of Environmental Sciences and Technology <a href="http://www.iest.org">www.iest.org</a>
IGMA	Insulating Glass Manufacturers Alliance <a href="http://www.igmaonline.org">www.igmaonline.org</a>
IGSHPA	International Ground Source Heat Pump Association <a href="http://www.igshpa.okstate.edu">www.igshpa.okstate.edu</a>
ILI	Indiana Limestone Institute of America, Inc. <a href="http://www.iliai.com">www.iliai.com</a>
Intertek	Intertek Group (Formerly: ETL SEMCO; Intertek Testing Service NA) <a href="http://www.intertek.com">www.intertek.com</a>
ISA	International Society of Automation (The) (Formerly: Instrumentation, Systems, and Automation Society) <a href="http://www.isa.org">www.isa.org</a>
ISAS	Instrumentation, Systems, and Automation Society (The) (See ISA)
ISFA	International Surface Fabricators Association (Formerly: International Solid Surface Fabricators Association) <a href="http://www.isfanow.org">www.isfanow.org</a>

ISO	International Organization for Standardization <a href="http://www.iso.org">www.iso.org</a>
ISSFA	International Solid Surface Fabricators Association (See ISFA)
ITU	International Telecommunication Union <a href="http://www.itu.int/home">www.itu.int/home</a>
KCMA	Kitchen Cabinet Manufacturers Association <a href="http://www.kcma.org">www.kcma.org</a>
LMA	Laminating Materials Association (See CPA)
LPI	Lightning Protection Institute <a href="http://www.lightning.org">www.lightning.org</a>
MBMA	Metal Building Manufacturers Association <a href="http://www.mbma.com">www.mbma.com</a>
MCA	Metal Construction Association <a href="http://www.metalconstruction.org">www.metalconstruction.org</a>
MFMA	Maple Flooring Manufacturers Association, Inc. <a href="http://www.maplefloor.org">www.maplefloor.org</a>
MFMA	Metal Framing Manufacturers Association, Inc. <a href="http://www.metalframingmfg.org">www.metalframingmfg.org</a>
MHIA	Material Handling Industry of America <a href="http://www.mhia.org">www.mhia.org</a>
MIA	Marble Institute of America <a href="http://www.marble-institute.com">www.marble-institute.com</a>
MMPA	Moulding & Millwork Producers Association (Formerly: Wood Moulding & Millwork Producers Association) <a href="http://www.wmmpa.com">www.wmmpa.com</a>
MPI	Master Painters Institute <a href="http://www.paintinfo.com">www.paintinfo.com</a>
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. <a href="http://www.mss-hq.org">www.mss-hq.org</a>

NAAMM	National Association of Architectural Metal Manufacturers <a href="http://www.naamm.org">www.naamm.org</a>
NACE	NACE International (National Association of Corrosion Engineers International) <a href="http://www.nace.org">www.nace.org</a>
NADCA	National Air Duct Cleaners Association <a href="http://www.nadca.com">www.nadca.com</a>
NAIMA	North American Insulation Manufacturers Association <a href="http://www.naima.org">www.naima.org</a>
NBGQA	National Building Granite Quarries Association, Inc. <a href="http://www.nbgqa.com">www.nbgqa.com</a>
NCAA	National Collegiate Athletic Association (The) <a href="http://www.ncaa.org">www.ncaa.org</a>
NCMA	National Concrete Masonry Association <a href="http://www.ncma.org">www.ncma.org</a>
NEBB	National Environmental Balancing Bureau <a href="http://www.nebb.org">www.nebb.org</a>
NECA	National Electrical Contractors Association <a href="http://www.necanet.org">www.necanet.org</a>
NeLMA	Northeastern Lumber Manufacturers Association <a href="http://www.nelma.org">www.nelma.org</a>
NEMA	National Electrical Manufacturers Association <a href="http://www.nema.org">www.nema.org</a>
NETA	InterNational Electrical Testing Association <a href="http://www.netaworld.org">www.netaworld.org</a>
NFHS	National Federation of State High School Associations <a href="http://www.nfhs.org">www.nfhs.org</a>
NFPA	NFPA (National Fire Protection Association) <a href="http://www.nfpa.org">www.nfpa.org</a>
NFPA	NFPA International (See NFPA)

NFRC	National Fenestration Rating Council <a href="http://www.nfrc.org">www.nfrc.org</a>
NHLA	National Hardwood Lumber Association <a href="http://www.nhla.com">www.nhla.com</a>
NLGA	National Lumber Grades Authority <a href="http://www.nlga.org">www.nlga.org</a>
NOFMA	National Oak Flooring Manufacturers Association (See NWFA)
NOMMA	National Ornamental & Miscellaneous Metals Association <a href="http://www.nomma.org">www.nomma.org</a>
NRCA	National Roofing Contractors Association <a href="http://www.nrca.net">www.nrca.net</a>
NRMCA	National Ready Mixed Concrete Association <a href="http://www.nrmca.org">www.nrmca.org</a>
NSF	NSF International (National Sanitation Foundation International) <a href="http://www.nsf.org">www.nsf.org</a>
NSPE	National Society of Professional Engineers <a href="http://www.nspe.org">www.nspe.org</a>
NSSGA	National Stone, Sand & Gravel Association <a href="http://www.nssga.org">www.nssga.org</a>
NTMA	National Terrazzo & Mosaic Association, Inc. (The) <a href="http://www.ntma.com">www.ntma.com</a>
NWFA	National Wood Flooring Association <a href="http://www.nwfa.org">www.nwfa.org</a>
PCI	Precast/Prestressed Concrete Institute <a href="http://www.pci.org">www.pci.org</a>
PDI	Plumbing & Drainage Institute <a href="http://www.pdionline.org">www.pdionline.org</a>
PLASA	PLASA (Formerly: ESTA - Entertainment Services and Technology Association)

	<a href="http://www.plasa.org">www.plasa.org</a>
RCSC	Research Council on Structural Connections <a href="http://www.boltcouncil.org">www.boltcouncil.org</a>
RFCI	Resilient Floor Covering Institute <a href="http://www.rfci.com">www.rfci.com</a>
RIS	Redwood Inspection Service <a href="http://www.redwoodinspection.com">www.redwoodinspection.com</a>
SAE	SAE International (Society of Automotive Engineers) <a href="http://www.sae.org">www.sae.org</a>
SBCCI	Southern Building Code Congress International, Inc. (See ICC)
SCTE	Society of Cable Telecommunications Engineers <a href="http://www.scte.org">www.scte.org</a>
SDI	Steel Deck Institute <a href="http://www.sdi.org">www.sdi.org</a>
SDI	Steel Door Institute <a href="http://www.steeldoor.org">www.steeldoor.org</a>
SEFA	Scientific Equipment and Furniture Association <a href="http://www.sefalabs.com">www.sefalabs.com</a>
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SIA	Security Industry Association <a href="http://www.siaonline.org">www.siaonline.org</a>
SJI	Steel Joist Institute <a href="http://www.steeljoist.org">www.steeljoist.org</a>
SMA	Screen Manufacturers Association <a href="http://www.smainfo.org">www.smainfo.org</a>
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association <a href="http://www.smacna.org">www.smacna.org</a>



SMPTE	Society of Motion Picture and Television Engineers <a href="http://www.smpte.org">www.smpte.org</a>
SPFA	Spray Polyurethane Foam Alliance <a href="http://www.sprayfoam.org">www.sprayfoam.org</a>
SPIB	Southern Pine Inspection Bureau <a href="http://www.spib.org">www.spib.org</a>
SPRI	Single Ply Roofing Industry <a href="http://www.spri.org">www.spri.org</a>
SRCC	Solar Rating and Certification Corporation <a href="http://www.solar-rating.org">www.solar-rating.org</a>
SSINA	Specialty Steel Industry of North America <a href="http://www.ssina.com">www.ssina.com</a>
SSPC	SSPC: The Society for Protective Coatings <a href="http://www.sspc.org">www.sspc.org</a>
STI	Steel Tank Institute <a href="http://www.steeltank.com">www.steeltank.com</a>
SWI	Steel Window Institute <a href="http://www.steelwindows.com">www.steelwindows.com</a>
SWPA	Submersible Wastewater Pump Association <a href="http://www.swpa.org">www.swpa.org</a>
TCA	Tilt-Up Concrete Association <a href="http://www.tilt-up.org">www.tilt-up.org</a>
TCNA	Tile Council of North America, Inc. (Formerly: Tile Council of America) <a href="http://www.tileusa.com">www.tileusa.com</a>
TEMA	Tubular Exchanger Manufacturers Association, Inc. <a href="http://www.tema.org">www.tema.org</a>
TIA	Telecommunications Industry Association (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance) <a href="http://www.tiaonline.org">www.tiaonline.org</a>
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance

(See TIA)

TMS	The Masonry Society <a href="http://www.masonrysociety.org">www.masonrysociety.org</a>
TPI	Truss Plate Institute <a href="http://www.tpinst.org">www.tpinst.org</a>
TPI	Turfgrass Producers International <a href="http://www.turfgrassod.org">www.turfgrassod.org</a>
TRI	Tile Roofing Institute <a href="http://www.tilerroofing.org">www.tilerroofing.org</a>
UBC	Uniform Building Code (See ICC)
UL	Underwriters Laboratories Inc. <a href="http://www.ul.com">www.ul.com</a>
UNI	Uni-Bell PVC Pipe Association <a href="http://www.uni-bell.org">www.uni-bell.org</a>
USAV	USA Volleyball <a href="http://www.usavolleyball.org">www.usavolleyball.org</a>
USGBC	U.S. Green Building Council <a href="http://www.usgbc.org">www.usgbc.org</a>
USITT	United States Institute for Theatre Technology, Inc. <a href="http://www.usitt.org">www.usitt.org</a>
WASTECH	Waste Equipment Technology Association <a href="http://www.wastec.org">www.wastec.org</a>
WCLIB	West Coast Lumber Inspection Bureau <a href="http://www.wclib.org">www.wclib.org</a>
WCMA	Window Covering Manufacturers Association <a href="http://www.wcmanet.org">www.wcmanet.org</a>
WDMA	Window & Door Manufacturers Association <a href="http://www.wdma.com">www.wdma.com</a>
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California) <a href="http://www.wicnet.org">www.wicnet.org</a>

WMMPA	Wood Moulding & Millwork Producers Association (See MMPA)
WSRCA	Western States Roofing Contractors Association <a href="http://www.wsrca.com">www.wsrca.com</a>
WWPA	Western Wood Products Association <a href="http://www.wwpa.org">www.wwpa.org</a>

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DIN Deutsches Institut für Normung e.V.  
[www.din.de](http://www.din.de)

IAPMO International Association of Plumbing and Mechanical Officials  
[www.iapmo.org](http://www.iapmo.org)

ICC International Code Council  
[www.iccsafe.org](http://www.iccsafe.org)

ICC-ES ICC Evaluation Service, LLC  
[www.icc-es.org](http://www.icc-es.org)

(562) 699-0543

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

COE Army Corps of Engineers  
[www.usace.army.mil](http://www.usace.army.mil)

CPSC Consumer Product Safety Commission  
[www.cpsc.gov](http://www.cpsc.gov)

DOC Department of Commerce  
National Institute of Standards and Technology  
[www.nist.gov](http://www.nist.gov)

DOD Department of Defense  
<http://dodssp.daps.dla.mil>

DOE Department of Energy  
[www.energy.gov](http://www.energy.gov)

EPA	Environmental Protection Agency <a href="http://www.epa.gov">www.epa.gov</a>
FAA	Federal Aviation Administration <a href="http://www.faa.gov">www.faa.gov</a>
FG	Federal Government Publications <a href="http://www.gpo.gov">www.gpo.gov</a>
GSA	General Services Administration <a href="http://www.gsa.gov">www.gsa.gov</a>
HUD	Department of Housing and Urban Development <a href="http://www.hud.gov">www.hud.gov</a>
LBL	Lawrence Berkeley National Laboratory Environmental Energy Technologies Division <a href="http://eetd.lbl.gov">http://eetd.lbl.gov</a>
OSHA	Occupational Safety & Health Administration <a href="http://www.osha.gov">www.osha.gov</a>
SD	Department of State <a href="http://www.state.gov">www.state.gov</a>
TRB	Transportation Research Board National Cooperative Highway Research Program <a href="http://www.trb.org">www.trb.org</a>
USDA	Department of Agriculture Agriculture Research Service U.S. Salinity Laboratory <a href="http://www.ars.usda.gov">www.ars.usda.gov</a>
USDA	Department of Agriculture Rural Utilities Service <a href="http://www.usda.gov">www.usda.gov</a>
USDJ	Department of Justice Office of Justice Programs National Institute of Justice <a href="http://www.ojp.usdoj.gov">www.ojp.usdoj.gov</a>
USP	U.S. Pharmacopeia <a href="http://www.usp.org">www.usp.org</a>
USPS	United States Postal Service

[www.usps.com](http://www.usps.com)

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CFR Code of Federal Regulations  
Available from Government Printing Office  
[www.gpo.gov/fdsys](http://www.gpo.gov/fdsys)

DOD Department of Defense  
Military Specifications and Standards  
Available from Department of Defense Single Stock Point  
<http://dodssp.daps.dla.mil>

DSCC Defense Supply Center Columbus  
(See FS)

FED-STD Federal Standard  
(See FS)

FS Federal Specification  
Available from Department of Defense Single Stock Point  
<http://dodssp.daps.dla.mil>

Available from Defense Standardization Program  
[www.dsp.dla.mil](http://www.dsp.dla.mil)

Available from General Services Administration  
[www.gsa.gov](http://www.gsa.gov)

Available from National Institute of Building Sciences/Whole Building  
Design Guide  
[www.wbdg.org/ccb](http://www.wbdg.org/ccb)

MILSPEC Military Specification and Standards  
(See DOD)

USAB United States Access Board  
[www.access-board.gov](http://www.access-board.gov)

USATBCB U.S. Architectural & Transportation Barriers Compliance Board  
(See USAB)

E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or

other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

- CBHF      State of California  
            Department of Consumer Affairs  
            Bureau of Electronic Appliance and Repair, Home Furnishings and  
            Thermal Insulation  
            www.bearhfti.ca.gov
- CCR        California Code of Regulations  
            Office of Administrative Law  
            California Title 24 Energy Code  
            www.calregs.com
- CDHS      California Department of Health Care Services  
            (Formerly: California Department of Health Services)  
            (See CCR)
- CDPH      California Department of Public Health  
            Indoor Air Quality Program  
            www.cal-iaq.org
- CPUC      California Public Utilities Commission  
            www.cpuc.ca.gov
- SCAQMD   South Coast Air Quality Management District  
            www.aqmd.gov
- TFS        Texas Forest Service  
            Forest Resource Development and Sustainable Forestry  
            http://txforestservicetamu.edu

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

## SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
  - 2. Section 012100 "Allowances" for allowance for metered use of temporary utilities.

#### 1.3 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Engineer, Architect, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: **Contractor will pay** sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: **Contractor will pay** water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: **Contractor will pay** electric-power-service use charges for electricity used by all entities for construction operations.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within **15** days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
  - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
  - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
  - 3. Indicate methods to be used to avoid trapping water in finished work.

## 1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

## 1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide **concrete** or **galvanized steel** bases for supporting posts.



## 2.2 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
  - 1. Store combustible materials apart from building.

## 2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

## PART 3 - EXECUTION

### 3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
  - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

### 3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
  - 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

### 3.3 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to **municipal system** as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
  1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities **is not permitted**.
- F. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
  1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
- H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- I. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Engineer/Architect and Owner.

### 3.4 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
  1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
  2. Alternatively, utilize designated area within existing building for temporary field offices.
  3. Maintain support facilities until Engineer/Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial

Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
  - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: **Designate** parking areas for construction personnel.
- D. Storage and Staging: **Designate areas of Project site** for storage and staging needs.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
  - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
  - 2. Remove snow and ice as required to minimize accumulations.
- F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
  - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
  - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  - 3. Maintain and touch up signs, so they are legible at all times.
- G. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
  - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

### 3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
  - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
  - 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Temporary Erosion and Sedimentation Control: Comply with **requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and** requirements specified in Section 311000 "Site Clearing."
- D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to **requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.**
  - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
  - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
  - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
  - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- E. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- H. Site Enclosure Fence: **Before construction operations begin**], furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
  - 1. Extent of Fence: **As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.**
  - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. **Furnish one set of keys to Owner.**
- I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- K. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
  - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
  - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
  - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

### 3.6 MOISTURE AND MOLD CONTROL

- A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
  - 1. Protect porous materials from water damage.
  - 2. Protect stored and installed material from flowing or standing water.
  - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
  - 4. Remove standing water from decks.
  - 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
  - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
  - 2. Keep interior spaces reasonably clean and protected from water damage.

3. Periodically collect and remove waste containing cellulose or other organic matter.
  4. Discard or replace water-damaged material.
  5. Do not install material that is wet.
  6. Discard and replace stored or installed material that begins to grow mold.
  7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
  2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
  3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
    - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for **48** hours are considered defective and require replacing.
    - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for **48** hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Engineer/Architect.
    - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within **48** hours.

### 3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.

2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 01 50 00

## SECTION 01 60 00 - PRODUCT REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
  - 2. Section 012100 "Allowances" for products selected under an allowance.
  - 3. Section 012300 "Alternates" for products selected under an alternate.
  - 4. Section 012500 "Substitution Procedures" for requests for substitutions.
  - 5. Section 014200 "References" for applicable industry standards for products specified.
  - 6. Section 017700 "Closeout Procedures" for submitting warranties.

#### 1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
  - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model



number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
  2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.
- 1.4 QUALITY ASSURANCE
- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
  2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

- a. Name of product and manufacturer.
  - b. Model and serial number.
  - c. Capacity.
  - d. Speed.
  - e. Ratings.
3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

#### 1.5 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

#### 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.
- C. Storage:
  1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
  2. Store products to allow for inspection and measurement of quantity or counting of units.
  3. Store materials in a manner that will not endanger Project structure.
  4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
  5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
  6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  7. Protect stored products from damage and liquids from freezing.

## 1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
  - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  - 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
  - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
  - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  - 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
  - 4. Where products are accompanied by the term "as selected," Engineer/Architect will make selection.
  - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
  - 6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

- a. Submit additional documentation required by Engineer/Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Engineer/Architect, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience **will not** be considered **unless otherwise indicated**.
  - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
  - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
  - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience **will not** be considered **unless otherwise indicated**.
  - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

- a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
  - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require the phrase "match Engineer/Architect's sample," provide a product that complies with requirements and matches Engineer/Architect's sample. Engineer/Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer/Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Engineer/Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Engineer/Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect may return requests without action, except to record noncompliance with the following requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects, with project names and addresses and names and addresses of Engineer/Architects and owners, if requested.
  5. Samples, if requested.

- B. Engineer/Architect's Action on Comparable Products Submittal: If necessary, Engineer/Architect will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."
  - 1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
  - 2. Use product specified if Engineer/Architect does not issue a decision on use of a comparable product request within time allocated.
  
- C. Submittal Requirements, Two-Step Process: Approval by the Engineer/Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

## SECTION 01 73 00 - EXECUTION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner's portion of the Work.
6. Coordination of Owner-installed products.
7. Progress cleaning.
8. Starting and adjusting.
9. Protection of installed construction.

- B. Related Requirements:

1. Section 011000 "Summary" for coordination of **Owner-furnished products, Owner-performed work**, and limits on use of Project site.
2. Section 013300 "Submittal Procedures" for submitting surveys.
3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

#### 1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

#### 1.4 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at **Project site**.

1. Prior to **commencing work requiring cutting and patching**, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Inform Engineer/Architect of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
  - a. Contractor's superintendent.
  - b. Trade supervisor responsible for cutting operations.
  - c. Trade supervisor(s) responsible for patching of each type of substrate.
  - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.
2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

B. Layout Conference: Conduct conference at **Project sites**

1. Prior to establishing layout of **new and existing** perimeter and structural column grid(s), review building location requirements. Review benchmark, control point, and layout and dimension requirements. Inform Engineer/Architect of scheduled meeting. Require representatives of each entity directly concerned with Project layout to attend, including the following:
  - a. Contractor's superintendent.
  - b. **Professional surveyor and Contractor's personnel** responsible for performing Project surveying and layout.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **land surveyor**.
- B. Certified Surveys: Submit **two** copies signed by **land surveyor**.
- C. Certificates: Submit certificate signed by **land surveyor**, certifying that location and elevation of improvements comply with requirements.
- D. Cutting and Patching Plan: Submit plan describing procedures at least **10** days prior to the time cutting and patching will be performed. Include the following information:
  1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
  2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
  3. Products: List products to be used for patching and firms or entities that will perform patching work.
  4. Dates: Indicate when cutting and patching will be performed.
  5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.



- a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

- E. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

## 1.6 CLOSEOUT SUBMITTALS

- A. Final Property Survey: Submit **10** copies showing the Work performed and record survey data.

## 1.7 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

- B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."

- C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Engineer/Architect of locations and details of cutting and await directions from Engineer/Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. **Operational elements include the following:**

- a. Primary operational systems and equipment.
- b. Fire separation assemblies.
- c. Air or smoke barriers.
- d. Fire-suppression systems.
- e. Plumbing piping systems.
- f. Mechanical systems piping and ducts.
- g. Control systems.
- h. Communication systems.
- i. Fire-detection and -alarm systems.
- j. Conveying systems.
- k. Electrical wiring systems.
- l. Operating systems of special construction.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or

decreased operational life or safety. **Other construction elements include but are not limited to the following:**

- a. Water, moisture, or vapor barriers.
  - b. Membranes and flashings.
  - c. Exterior curtain-wall construction.
  - d. Sprayed fire-resistive material.
  - e. Equipment supports.
  - f. Piping, ductwork, vessels, and equipment.
  - g. Noise- and vibration-control elements and systems.
  - h. **Tiled surfaces**
  - i. **Casework.**
4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer/Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer/Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.
- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate

and verify the existence and location of underground utilities and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
  2. List of detrimental conditions, including substrates.
  3. List of unacceptable installation tolerances.
  4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to **local utility** and **Owner** that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer/Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Engineer/Architect promptly.
- B. Engage a **land surveyor** experienced in laying out the Work, using the following accepted surveying practices:
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish limits on use of Project site.
  - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 4. Inform installers of lines and levels to which they must comply.
  - 5. Check the location, level and plumb, of every major element as the Work progresses.
  - 6. Notify Engineer/Architect when deviations from required lines and levels exceed allowable tolerances.
  - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer/Architect.

### 3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
  - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer/Architect. Report lost or destroyed permanent benchmarks or

- control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer/Architect before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of [**two**] permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Final Property Survey: Engage a **land surveyor** to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by **land surveyor**, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
  2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

### 3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
  2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
  4. Maintain minimum headroom clearance of **96 inches** in occupied spaces and **90 inches** in unoccupied spaces, unless otherwise indicated on Drawings.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Engineer/Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer/Architect.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Engineer/Architect. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.
  - 1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

### 3.6 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.

- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. **[Concrete] [and] [Masonry]**: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
  5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
- F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Engineer/Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### 3.7 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
  1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 90 deg F.
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
  1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in **Section 015000 "Temporary Facilities and Controls."**
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.



- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.8 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

### 3.9 PROTECTION AND REPAIR OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- D. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 01 73 00

## SECTION 019100.15 - TOTAL BUILDING COMMISSIONING

### PART 1 GENERAL

#### 1.1 SUMMARY

Commission the building systems listed herein. Contractor to employ the services of an independent Commissioning Firm. The Commissioning Firm must be a 1st tier subcontractor of the General or Prime Contractor and must be financially and corporately independent of all other subcontractors. The Commissioning Firm must employ a Lead Commissioning Specialist that coordinates all aspects of the commissioning process. Conform to the commissioning procedures outlined in this specification.

#### 1.2 SYSTEMS TO BE COMMISSIONED

Commission the following systems:

Heating, Ventilating, Air Conditioning, and Refrigeration Systems (HVAC)  
Building Automation System

#### 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE 202 (2018) Commissioning Process for Buildings and Systems

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline (2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard (2009) Procedural Standards for Whole Building Systems  
Commissioning of New Construction; 3rd Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL  
ASSOCIATION (SMACNA)

ANSI/SMACNA 014 (2013) HVAC Systems Commissioning Manual, 2nd Edition

#### 1.4 COMMUNICATION WITH THE OWNER

The Lead Commissioning Specialist (Cx) must submit all plans, schedules, reports, and documentation directly to the Contracting Officer Representative concurrent with submission to the CQC System Manager. The Lead Commissioning Specialist must have direct communication with the Contracting Officer's Representative regarding all elements of the commissioning process; however, the Owner has no direct contract authority with the Lead Commissioning Specialist.

## 1.5 SEQUENCING AND SCHEDULING

### 1.5.1 Sequencing

Complete the following prior to starting Functional Performance Tests of mechanical systems:

- a. All equipment and systems have been completed, cleaned, flushed, disinfected, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications.
- b. Performance Verification Tests of the controls systems have been completed and the Performance Verification Test Report has been submitted and approved in accordance with Specification Section 230900 INSTRUMENTATION AND CONTROL FOR HVAC.
- c. Testing, Adjusting, and Balancing has been completed and the Testing, Adjusting, and Balancing Report, has been submitted and approved in accordance with Specification Section 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- d. The building envelope is enclosed according to contract documents with final construction completed.
- e. The Pre-Functional Checklists have been submitted and approved.
- f. The Certificate of Readiness for mechanical systems has been submitted and approved.

### 1.5.2 Project Schedule

Include the following tasks in the project schedule. Ensure sufficient time is scheduled to accommodate the requirements of this specification section. The order of items listed below is not intended to imply a specified sequence:

- a. Submission and approval of the Commissioning Firm and Commissioning Specialist
- b. Submission and approval of the Testing, Adjusting, and Balancing (TAB) Firm and TAB Specialist specified in Specification Section 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC
- c. Submission and approval of the Construction Phase Commissioning Plan
- d. Installation of permanent utilities (gas, water, electric)
- e. Factory Acceptance Testing for each of the systems to be commissioned as required by technical specifications
- f. Manufacturer's Equipment Start-Up for each of the systems to be commissioned.
- g. Submission and approval of the TAB Schematic Drawings, Report Forms, and Procedures specified in Specification Section 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- h. Testing, Adjusting, and Balancing (TAB) Field Work required by Specification Section 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC

- i. Submission and approval of the TAB Report specified in Specification Section 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC
- j. TAB Field Acceptance Testing required by Specification Section 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC
- k. Performance Verification Test Report specified in Specification Section 230900 INSTRUMENTATION AND CONTROL FOR HVAC.
- l. Pre-Functional Checklist Submittal
- m. Functional Performance Testing for each system to be commissioned
- n. Post-Test Deficiency Correction for each system to be commissioned
- o. Re-Testing
- p. Training for each of the systems to be commissioned
- q. Submission and approval of the Commissioning Report

#### 1.6 SUBMITTALS

Submit the following in accordance with Section 013300 SUBMITTAL PROCEDURES:

##### Preconstruction Submittals

Commissioning Firm

Lead Commissioning Specialist

Technical Commissioning Specialists

##### Test Reports

Final Construction Phase Commissioning Plan

Pre-Functional Checklists

Issues Log

Commissioning Report

##### Certificates

Certificate of Readiness

Operation and Maintenance Data

Training Plan

## Training Attendance Rosters

### 1.7 COMMISSIONING FIRM

Provide a Commissioning Firm that is certified in commissioning by one of the following: the AABC Commissioning Group (ACG); the National Environmental Balancing Bureau (NEBB); the International Certification Board/Testing, Adjusting, and Balancing Bureau (ICB/TABB), the Building Commissioning Association (BCA); the Association of Energy Engineers (AEE). The Commissioning Firm must be certified in all systems to be commissioned to the extent such certifications are available from the certifying body. Describe any lapses in certification or disciplinary action taken by the certifying body against the proposed Commissioning Firm or Lead Commissioning Specialist in detail. Any firm or commissioning professional that has been the subject of disciplinary action by the certifying body within the five years preceding contract award is not eligible to perform any duties related to commissioning.

- a. Submit the Commissioning Firm's certification of qualifications including the name of the firm and certifications no later than 30 calendar days after Notice to Proceed. Submit one hard copy and an electronic copy.
- b. The Commissioning Firm's and Commissioning Specialists' certifications must be maintained for the entire duration of the duties specified herein. If, for any reason, the firm or a specialist loses a certification during this period, immediately notify the Contracting Officer's Representative and submit another Commissioning Firm or Commissioning Specialist for approval. All work specified in this specification section performed by the Commissioning Firm or associated Commissioning Specialists is invalid if the Commissioning Firm or Commissioning Specialist loses its certification prior to contract completion and must be performed by an approved successor.
- c. The Commissioning Firm must oversee and assist the General or Prime Contractor with the work specified herein.

#### 1.7.1 Lead Commissioning Specialist

The Commissioning Firm must provide a Lead Commissioning Specialist (CxC) that has a minimum of five years of commissioning experience, including two projects of similar size and complexity, and that is one of the following: a NEBB qualified Systems Commissioning Administrator (SCA); ACG Certified Commissioning Authority (CxA); ICB/TABB Certified Commissioning Supervisor; BCA Certified Commissioning Professional (CCP); AEE Certified Building Commissioning Professional (CBCP); Building Commissioning Professional (BCxP).

- a. Submit the Lead Commissioning Specialist's certification of qualifications including the name of the specialist and firm; certifications; years of experience; and a listing of representative projects of similar size and complexity no later than 30 calendar days after Notice to Proceed. Submit one hard copy and an electronic copy.
- b. The Lead Commissioning Specialists certifications must be maintained for the entire duration of the duties specified herein. If, for any reason, the specialist loses a certification during this period, immediately notify the Contracting Officer's Representative and submit another Lead Commissioning Specialist for approval. All work specified in this specification section to be performed by the Lead Commissioning Specialist is invalid if the Lead Commissioning Specialist

loses its certification prior to contract completion and must be performed by an approved successor.

- c. The Lead Commissioning Specialist must lead and oversee the commissioning work specified herein and be the primary point of contact for the Owner regarding the commissioning work. One of the Technical Commissioning Specialists may be the Lead Commissioning Specialist provided that all of the qualification requirements are met.

#### 1.7.2 Technical Commissioning Specialists

Technical Commissioning Specialists, employed by the Commissioning Firm and that have the following qualifications, must perform the technical work specified herein associated with each system to be commissioned:

- a. Mechanical Technical Commissioning Specialist: The technical work associated with mechanical systems including Heating, Ventilating, Air Conditioning, and Refrigeration Systems; Building Automation System; must be performed by a Commissioning Specialist certified by NEBB, ACG, ICB/TABB, or BCA in the commissioning of HVAC systems with five years of experience in the commissioning of HVAC systems.
- b. Submit the Technical Commissioning Specialist's certification of qualifications including the name of the specialist and firm; certifications; years of experience; and a listing of representative projects of similar size and complexity no later than 30 calendar days after Notice to Proceed. Submit one hard copy and an electronic copy.

#### 1.7.3 Commissioning Standard

Comply with the requirements of the commissioning standard under which the Commissioning Firm and Specialists qualifications are approved. When the firm and specialists are certified by BCA, AEE, ASHRAE, or the University of Wisconsin-Madison, comply with the requirements of one of the acceptable standards unless otherwise stated herein. The acceptable standards are ACG Commissioning Guideline, NEBB Commissioning Standard, ANSI/SMACNA 014, or ASHRAE 202. Comply with applicable NETA testing standards for electrical systems.

- a. Implement all recommendations and suggested practices contained in the Commissioning Standard and electrical test standards.
- b. Use the Commissioning Standard for all aspects of Commissioning, including calibration of instruments.
- c. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, adhere to the manufacturer calibration recommendations.
- d. All quality assurance provisions of the Commissioning Standard such as performance guarantees are part of this contract.
- e. The Commissioning Specialists must develop commissioning procedures for any systems or system components not covered in the Commissioning Standard.
- f. Use any new requirements, recommendations, and procedures published or adopted prior to contract solicitation by the body responsible for the Commissioning Standard.

## 1.8 ISSUES LOG

The Lead Commissioning Specialist must develop and maintain an Issues Log for tracking and resolution of all deficiencies discovered through submittal reviews, inspection, and testing. Include the date of final resolution of issues as confirmed by the Commissioning Specialist. Submit the Issues Log on a monthly basis at a minimum. At any point during construction, any commissioning team member finding deficiencies may communicate those deficiencies in writing to the Commissioning Specialist for inclusion into the Issues Log.

## 1.9 CERTIFICATE OF READINESS

Prior to scheduling Functional Performance Tests for each system, issue a Certificate of Readiness for the system certifying that the system is ready for Functional Performance Testing. The Certificate of Readiness must include, for each system to be commissioned, all equipment and system start-up reports; Performance Verification Test Reports; completed Pre-Functional Checklists; Testing, Adjusting, and Balancing (TAB) Report; HVAC Controls Start-Up Reports to the extent applicable to the system. The Contractor; the Lead Commissioning Specialist; the Contractor's Quality Control Representative; the Mechanical, Electrical, Controls, and TAB subcontractor representatives must sign and date the Certificate of Readiness. Submit the Certificate of Readiness for each system no later than 14 calendar days prior to Functional Performance Tests of that system. Submit one hard copy and an electronic copy. Do not schedule Functional Performance Tests for a system until the Certificate of Readiness for that system receives approval by the Owner's Representative.

## PART 2 PRODUCTS

Not used

## PART 3 EXECUTION

### 3.1 CONSTRUCTION PHASE

#### 3.1.1 Construction Commissioning Coordination Meeting

The Lead Commissioning Specialist must lead a Construction Commissioning Coordination Meeting no later than 14 days after approval of the Commissioning Firm and Commissioning Specialists to discuss the commissioning process including contract requirements, lines of communication, roles and responsibilities, schedules, documentation requirements, inspection and test procedures, and logistics as specified in this specification section. The Contractor's Superintendent or Project Manager, the Contractor's Quality Control Representative, and the Owner's Representative must attend this meeting.

#### 3.1.2 Construction Phase Commissioning Plan

##### 3.1.2.1 Final Construction Phase Commissioning Plan

The Lead Commissioning Specialist (Cx) must prepare the Final Construction Phase Commissioning Plan. Submit the Final Construction Phase Commissioning Plan no later than 30 calendar days prior to the start of Pre-Functional Checks. Submit one hard copy and an electronic copy.

The Technical Commissioning Specialist must develop the Pre-Functional Checklists and Functional Performance Test Checklists for each building, for each system required to be commissioned, and for each component for inclusion in the Final Construction Phase Commissioning Plan.

#### 3.1.2.1.1 Pre-Functional Checklists

The Pre-Functional Checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph Pre-Functional Checks for more information.

#### 3.1.2.1.2 Functional Performance Test Checklists

Functional Performance Test Checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract. Refer to paragraph Functional Performance Tests for more information. Include the following sections and details appropriate to the systems being tested in the Functional Performance Test Checklists:

- a. Notable system features including information about controls to facilitate understanding of system operation
- b. Conclusions and recommendations. Conclusions must clearly indicate if system does or does not perform in accordance with contract requirements. Recommendation must clearly indicate that the system should or should not be accepted by the Owner.
- c. Test conditions including date, beginning and ending time, and beginning and ending outdoor air conditions
- d. Attendees
- e. Identification of the equipment involved in the test
- f. Control system feature identification
- g. Point-to-point observations including demonstrating system flow meters and sensors have been calibrated and are correctly displayed on the Operator work station
- h. Actuator operation observations demonstrating actuator responses to commands from the control system
- i. As-found condition of the system operation
- j. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.
- k. Space for comments for each test item.

#### 3.1.3 Construction Submittals

Provide all submittals associated with the systems to be commissioned, including shop drawings; equipment submittals; test plans, procedures, and reports; and resubmittal's to the Commissioning Specialists. The Technical Commissioning Specialist must review the submittals to the extent



necessary verify that the equipment and system installation will comply with the contract requirements and the requirements of the Basis of Design and the Owner's Project Requirements Document.

### 3.1.4 Inspection and Testing

Demonstrate that all system components have been installed, that each control device and item of equipment operates, and that the systems operate and perform, including interactive operation between systems, in accordance with contract documents and the Owner's Project Requirements. Requirements in related specification sections are independent from the requirements of this section and do not satisfy any of the requirements specified in this specification section. Provide all materials, services, and labor required to perform the Pre-Functional Checks and Functional Performance Tests.

#### 3.1.4.1 Commissioning Team

Provide a commissioning representative for each sub-contractor associated with the systems to be commissioned. Each commissioning representative is responsible for coordination of their respective sub-contractor's execution of the commissioning activities and participation in the inspection and testing required by this specification section. The designers listed below are the designers of record for their respective systems. Substitutes must be approved by the Contracting Officer's Representative.

##### 3.1.4.1.1 Mechanical System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of mechanical systems:

Designation	Function
CxM	Mechanical System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
MC	Contractor's Mechanical Commissioning Representative
EC	Contractor's Electrical Commissioning Representative
CC	Contractor's Controls Commissioning Representative
TABC	Contractor's TAB Commissioning Representative

##### 3.1.4.1.2 Mechanical Systems Test Team

The following team members must participate in Functional Performance of mechanical systems:

Designation	Function
CxM	Mechanical System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative

Designation	Function
CQC	Contractor's Quality Control Personnel
MC	Contractor's Mechanical Commissioning Representative
EC	Contractor's Electrical Commissioning Representative
CC	Contractor's Controls Commissioning Representative
TABC	Contractor's TAB Commissioning Representative

### 3.1.4.1.3 Other Pre-Functional and Functional Performance Participants

The following may participate as team members during Pre-Functional Checks and Functional Performance Testing:

Designation	Function
Owner	Owner's Representative
User	Using Agent's Representative

### 3.1.4.2 Pre-Functional Checks

Pre-Functional Checklists from the approved Final Construction Phase Commissioning Plan must be completed by the commissioning team. Complete one Pre-Functional Checklist for each individual item of equipment or system for each system required to be commissioned including, but not limited to, ductwork, piping, equipment, and controls. Indicate commissioning team member inspection and acceptance of each Pre-Functional Checklist item by initials. Acceptance of each Pre-Functional Checklist item by each team member indicates that item conforms to the construction contract requirements in their area of responsibility. Technical Commissioning Specialist acceptance of each Pre-Functional Checklist item indicates that each item has been installed correctly and in accordance with contract documents and the Owner's Project Requirements. Submit the completed and initialed Pre-Functional Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system. Submit one hard copy and an electronic copy. Include manufacturer start-up checklists associated with equipment with the submission of the Pre-Functional Checklists.

### 3.1.4.3 Testing, Adjusting, and Balancing (TAB) Report and Field Acceptance Testing

The Mechanical System Technical Commissioning Specialist must review the pre-final TAB Report required by Specification Section 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Identify any deficiencies to the Owner's Representative and the Contractor's Quality Control Personnel. Resolve all deficiencies prior to TAB Field Acceptance Testing.

### 3.1.4.4 HVAC Controls Test Reports

The Mechanical System Technical Commissioning Specialist must review the Start-Up Testing Report and the PVT Procedures and Reports required by Specification Section 230900 INSTRUMENTATION AND CONTROL FOR HVAC. Include a certification by the Mechanical System Technical Commissioning Specialist that the submittals contain no deficiencies or that the submittals do not

indicate any deficiencies in the HVAC systems or HVAC control systems with each of these submittals.

### 3.1.4.5 Tests

#### 3.1.4.5.1 Functional Performance Tests

Schedule Functional Performance Tests for each system only after the Certificate of Readiness has been approved by the Owner for the system. Correct all deficiencies identified through any prior review, inspection, or test activity before the start of Functional Performance Tests.

- a. Functional Performance Tests must be performed with the Owner's Quality Assurance Representative present.
- b. Abort Functional Performance Tests when any system deficiency prevents the successful completion of the test.
- c. Technical Commissioning Specialists must lead and document all Functional Performance Tests for the systems to be commissioned with the Contractor and appropriate sub-contractors performing the Functional Performance Tests. The representatives listed in the paragraph Commissioning Team must attend the tests. Abort Functional Performance Tests when any required commissioning team member is not present for the test.

##### 3.1.4.5.1.1 Checklist

Use the Functional Performance Test Checklists from the approved Final Construction Phase Commissioning Plan to guide the Functional Performance Tests. Functional Performance Tests must be performed for each item of equipment and each system required to be commissioned and verify all sensor calibrations, control responses, safeties, interlocks, operating modes, sequences of operation, capacities, lighting levels, and all other performance requirements comply with construction contract regardless of the specific items listed within the Functional Performance Test provided. Testing must progress from equipment or components to subsystems to systems to interlocks and connections between systems. The order of components and systems to be tested must be determined by the Technical Commissioning Specialists.

##### 3.1.4.5.1.2 Acceptance

Indicate acceptance of each item of equipment and systems tested by signature of each commissioning team member for each Functional Performance Test. The Contractor's Quality Control Representative and the Technical Commissioning Specialists must indicate acceptance after the equipment and systems are free of deficiencies.

#### 3.1.4.5.2 HVAC Test Methods

Perform Functional Performance Tests in accordance with the following:

##### 3.1.4.5.2.1 Prior to Testing

Prior to testing operating modes, sequences of operation, interlocks, and safeties, complete control point-to-point observations, test sensor calibrations, and test actuator commands.

### 3.1.4.5.2.2 Simulating Conditions

Over-writing control input values through the controls system is not acceptable, unless approved by the Owner's Representative. Identify proposed exceptions in a protocol submitted to the Owner's Representative for approval. Before simulating conditions, overwriting values (if approved), or changing set-points, calibrate all sensors, transducers and devices. Below are several examples of exceptions that would be considered acceptable:

- a. When varying static pressures inside ductwork cannot be simulated within the duct, and where a sensor signals the controls system to initiate sequences at various duct static pressures, it is acceptable to simulate the various pressures with a Pneumatic Squeeze-Bulb Type Signaling Device with gauge temporarily attached to the sensing tube leading to the transmitter. It is not acceptable to reset the various set-points, nor to simulate an electric analog signal (unless approved as noted above).
- b. Dirty filter pressure drops can be simulated using sheets of cardboard at filter face.
- c. Freeze-stat safeties can be simulated by packing portion of sensor with ice.
- d. High outside air temperatures can be simulated with a hair blower.
- e. High entering cooling coil temperatures can be used to simulate entering cooling coil conditions.
- f. Do not use signal generators to simulate sensor signals unless approved by the Owner's Representative, as noted above, for special cases.
- g. Control set points can be altered. For example, to see the air conditioning compressor lockout work at an outside air temperature below 55 degrees F, when the outside air temperature is above 55 degrees F, temporarily change the lockout set point to be 0 degrees F above the current outside air temperature. Caution: Set points are not to be raised or lowered to a point such that damage to the components, systems, or the building structure and/or contents will occur.
- h. Test duct mounted smoke detectors in accordance with the manufacturer's recommendations. Perform the tests with air system at minimum airflow condition in ductwork.
- i. Test current sensing relays used for fan and pump status signals to control system to indicate unit failure and run status by resetting the set point on the relay to simulate a lost belt or unit failure while the unit is running. Confirm that the failure alarm was generated and received at the control system. After the test is conducted, return the set point to its original set-point or a set-point as indicated by the Owner's Representative.

### 3.1.4.5.2.3 Setup

Perform each test under conditions that simulate actual conditions as close as is practically possible. Provide all necessary materials and system modifications to produce the necessary flows, pressures, temperatures, and other conditions necessary to execute the test according to the specified conditions. At completion of the test, return the affected building equipment and systems to their pre-test condition.

### 3.1.4.5.3 Sample Strategy

Perform Functional Performance Tests using the following sample strategy. Prepare and complete a Functional Performance Test Checklist for each and every piece of equipment installed on this job. Equipment Identifiers are as indicated on the design drawings:

Equipment Identifier	Sample Size (Percent)
RTU	100%
VAV	100%
EF	100%

### 3.1.4.5.4 Aborted Tests and Re-Testing

Abort Functional Performance Tests if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Reimburse the Owner for all costs associated with effort lost due to re-testing due to test failures and aborted tests. These costs must include salary, travel costs, and per diem for Owner's commissioning team members. Re-test only after all deficiencies identified during the original tests have been corrected.

#### 3.1.4.5.4.1 100 Percent Sample

Systems or equipment for which 100 percent sample size are tested fail if one or more of the test procedures results in discovery of a deficiency and the deficiency cannot be resolved within 5 minutes during the test.

Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system.

#### 3.1.4.5.4.2 Less than 100 Percent Sample

For systems tests with a sample size less than 100 percent, if one or more of the test procedures for an item of equipment or a system results in discovery of a deficiency, regardless of whether the deficiency is corrected during the sample tests, the item of equipment or system fails the test.

- a. If the system failure rate is 5 percent or less, meaning that 5 percent or less of the equipment or systems had at least one deficiency, re-test only on the items which experienced the initial failures.
- b. If the system failure rate is higher than 5 percent, meaning that more than 5 percent of equipment or systems tested had at least one deficiency, re-test the items which experienced the initial failures to the extent necessary to confirm that the deficiencies have been corrected. In addition, test another random sample of the same size as the initial sample for the first time. If the second random sample set has any failures, re-test those failed items and all remaining equipment and systems to complete 100 percent testing of that system type.

### 3.1.5 Training Plan

Develop a training plan which identifies all training required by specification sections associated with commissioned systems. Include a matrix listing each training requirement, content of the training, the trainer name, trainer contact information, and schedule and location of training. Submit one hard copy and an electronic copy of the Training Plan to the Commissioning Specialists and the Owner no later than 30 calendar days prior to the associated training.

Document training attendance using training attendance rosters and provide completed attendance rosters to the Commissioning Specialists and the Owner no later than 7 calendar days following the completion of training for each system to be commissioned. Submit one hard copy and an electronic copy.

### 3.2 COMMISSIONING REPORT

Following the completion of Functional Performance Tests, the Lead Commissioning Specialist must prepare a Commissioning Report.

- a. Include an executive summary describing the overall commissioning process, the results of the commissioning process, any outstanding deficiencies and recommended resolutions, and any seasonal testing that must be scheduled for a later date. Indicate, in the executive summary, whether the systems meet the requirements of the construction contract and the Owner's Project Requirements.
- b. Detail any deficiencies discovered during the commissioning process and the corrective actions taken in the report. Include the completed Pre-Functional Checklists, Functional Performance Test Checklists, the Commissioning Plans, the Issues Log, Performance Verification Test Reports, Training Attendance Rosters, the final TAB Report.
- c. Submit the Commissioning Report no later than 14 calendar days following commissioning team acceptance of all Functional Performance Tests with the exception of Seasonal Tests. Submit three hard copies and an electronic copy.

END OF SECTION 019100.15

## SECTION 01 77 00 - CLOSEOUT PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures.
  - 2. Final completion procedures.
  - 3. Warranties.
  - 4. Final cleaning.
- B. Related Requirements:
  - 1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
  - 2. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
  - 3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
  - 4. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

#### 1.3 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Engineer/Architect's use prior to Engineer/Architect's inspection, to determine if the Work is substantially complete.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

## 1.5 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest-control inspection.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

## 1.7 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of **[10]** days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
  - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
  - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by **[Engineer/Architect]**. Label with manufacturer's name and model number.
    - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain **[Engineer/Architect's]** **[Owner's]** signature for receipt of submittals.
  - 5. Submit testing, adjusting, and balancing records.
  - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of **[10]** days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.



1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
6. Advise Owner of changeover in utility services.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of [10] days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer/Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer/Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer/Architect, that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

## 1.8 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:

1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Engineer/Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer/Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.
5. Submit Final Completion photographic documentation.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer/Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer/Architect will prepare a final Certificate for Payment after

inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.9 LIST OF INCOMPLETE ITEMS

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, listed by room or space number.
2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
  - a. Project name.
  - b. Date.
  - c. Name of Engineer/Architect.
  - d. Name of Contractor.
  - e. Page number.
4. Submit list of incomplete items in one of the following formats:
  - a. MS Excel Electronic File: Engineer/Architect will return annotated file.
  - b. PDF Electronic File: Engineer/Architect will return annotated file.

#### 1.10 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Engineer/Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within [15] days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
  1. **Submit by email to Engineer/Architect.**
- E. Warranties in Paper Form:

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
  2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- F. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

- g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  - h. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
  - i. Vacuum and mop concrete.
  - j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
  - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
  - l. Remove labels that are not permanent.
  - m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  - p. Clean ducts, blowers, and coils..
  - q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
  - r. Clean strainers.
  - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste-disposal requirements in **Section 015000 "Temporary Facilities and Controls."** Insert an article on continuing inspections or consultations by Contractor if required. Possibly insert a schedule of approximate times for inspections.

### 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 01 77 00

## SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory manuals.
  - 2. Emergency manuals.
  - 3. Systems and equipment operation manuals.
  - 4. Systems and equipment maintenance manuals.
  - 5. Product maintenance manuals.
- B. Related Requirements:
  - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

#### 1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Engineer/Architect will comment on whether content of operation and maintenance submittals is acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
  - 1. Submit **by email to Engineer/Architect**. Enable reviewer comments on draft submittals.

2. Submit **three** paper copies. Engineer/Architect will return **two** copies.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least **15** days before commencing demonstration and training. Engineer/Architect will return copy with comments.
  1. Correct or revise each manual to comply with Engineer/Architect's comments. Submit copies of each corrected manual within **15** days of receipt of Engineer/Architect's comments and prior to commencing demonstration and training.
- D. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

#### 1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
  1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
  2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
  1. Binders: Heavy-duty, three-ring, vinyl-covered, [**loose-leaf**] binders, in thickness necessary to accommodate contents, sized to hold **8-1/2-by-11-inch** paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary, to provide essential information for proper operation or maintenance of equipment or system.
    - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, subject matter of contents, **and indicate Specification Section number on bottom of spine**. Indicate volume number for multiple-volume sets.
  2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
  - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
  - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
6. Photographs: If installations are unusual, consider using photographs instead of drawings.

#### 1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  1. Title page.
  2. Table of contents.
  3. Manual contents.
- B. Title Page: Include the following information:
  1. Subject matter included in manual.
  2. Name and address of Project.
  3. Name and address of Owner.
  4. Date of submittal.
  5. Name and contact information for Contractor.
  6. Name and contact information for Construction Manager.
  7. Name and contact information for Engineer/Architect.
  8. Name and contact information for Commissioning Authority.
  9. Names and contact information for major consultants to the Engineer/Architect that designed the systems contained in the manuals.
  10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
  1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

#### 1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
  - 1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
  - 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
  - 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

#### 1.8 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
  - 1. Type of emergency.
  - 2. Emergency instructions.
  - 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
  - 1. Fire.
  - 2. Flood.
  - 3. Gas leak.
  - 4. Water leak.
  - 5. Power failure.
  - 6. Water outage.
  - 7. System, subsystem, or equipment failure.
  - 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:



1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

## 1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  2. Performance and design criteria if Contractor has delegated design responsibility.
  3. Operating standards.
  4. Operating procedures.
  5. Operating logs.
  6. Wiring diagrams.
  7. Control diagrams.
  8. Piped system diagrams.
  9. Precautions against improper use.
  10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
  2. Manufacturer's name.
  3. Equipment identification with serial number of each component.
  4. Equipment function.
  5. Operating characteristics.
  6. Limiting conditions.
  7. Performance curves.
  8. Engineering data and tests.
  9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
  2. Equipment or system break-in procedures.

3. Routine and normal operating instructions.
  4. Regulation and control procedures.
  5. Instructions on stopping.
  6. Normal shutdown instructions.
  7. Seasonal and weekend operating instructions.
  8. Required sequences for electric or electronic systems.
  9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

#### 1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
    - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
  2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  3. Identification and nomenclature of parts and components.
  4. List of items recommended to be stocked as spare parts.

- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
    - 1. Test and inspection instructions.
    - 2. Troubleshooting guide.
    - 3. Precautions against improper maintenance.
    - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    - 5. Aligning, adjusting, and checking instructions.
    - 6. Demonstration and training video recording, if available.
  - E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
    - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
    - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
  - F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
  - G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
  - H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
    - 1. Include procedures to follow and required notifications for warranty claims.
  - I. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
    - 1. Do not use original project record documents as part of maintenance manuals.
- 1.11 PRODUCT MAINTENANCE MANUALS
- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
  - B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
  - C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference

Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

- D. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
  
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
  - 1. Inspection procedures.
  - 2. Types of cleaning agents to be used and methods of cleaning.
  - 3. List of cleaning agents and methods of cleaning detrimental to product.
  - 4. Schedule for routine cleaning and maintenance.
  - 5. Repair instructions.
  
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
  
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 23

## SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
  - 1. Record Drawings.
  - 2. Record specifications.
  - 3. Record Product Data.
  - 4. Miscellaneous record submittals.
- B. Related Requirements:
  - 1. Section 017300 "Execution" for final property survey.
  - 2. Section 017700 "Closeout Procedures" for general closeout procedures.
  - 3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit three (3) sets of marked-up record prints.
    - a. Final Submittal:
      - 1) Submit three paper-copy sets of marked-up record prints.
      - 2) Submit PDF electronic files of scanned Record Prints and three sets of file prints.
      - 3) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit **annotated PDF electronic files and three paper copies** of Project's Specifications, including addenda and Contract modifications.
- C. Record Product Data: Submit **annotated PDF electronic files and directories and three paper copies** of each submittal.
  - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit **annotated PDF electronic files and directories and three paper copies** of each submittal.
- E. Reports: Submit written report indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

#### 1.4 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.
    - c. Record data as soon as possible after obtaining it.
    - d. Record and check the markup before enclosing concealed installations.
    - e. Cross-reference record prints to corresponding photographic documentation.
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations.
    - d. Locations and depths of underground utilities.
    - e. Revisions to routing of piping and conduits.
    - f. Revisions to electrical circuitry.
    - g. Actual equipment locations.
    - h. Duct size and routing.
    - i. Locations of concealed internal utilities.
    - j. Changes made by Change Order or [**Construction**] Change Directive.
    - k. Changes made following Engineer/Architect's written orders.
    - l. Details not on the original Contract Drawings.
    - m. Field records for variable and concealed conditions.
    - n. Record information on the Work that is shown only schematically.
  - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
  - 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Engineer/Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Annotated PDF electronic file [**with comment function enabled**].
  2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
  3. Refer instances of uncertainty to Engineer/Architect for resolution.
  4. Engineer/Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
    - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Engineer/Architect's digital data files.
    - b. Engineer/Architect will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Format: Annotated PDF electronic file **with comment function enabled**.
  3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
  4. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer/Architect.
    - e. Name of Contractor.

## 1.5 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
  3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
  4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
  5. Note related Change Orders, **Record Product Data**, and Record Drawings where applicable.

- B. Format: Submit record specifications as [**annotated PDF electronic file** and/or **scanned PDF electronic file(s) of marked-up paper copy of Specifications**].

#### 1.6 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
  - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  - 3. Note related Change Orders, [**Record Specifications,**] and Record Drawings where applicable.
- C. Format: Submit Record Product Data as **annotated PDF electronic file**, and/or **scanned PDF electronic file(s) of marked-up paper copy of Product Data**.
  - 1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

#### 1.7 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
  - 1. Examples of miscellaneous record submittals in this article include documentation of foundation depths, special measurements, tests and inspections, surveys, mix records, and inspections by authorities having jurisdiction. If necessary, insert a list of specific submittals.
- B. Format: Submit miscellaneous record submittals as **PDF electronic file**, and/or **scanned PDF electronic file(s) of marked-up miscellaneous record submittals**.
  - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

#### 1.8 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible



condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer/Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 39

## SECTION 017900 - DEMONSTRATION AND TRAINING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
  - 1. Demonstration of operation of systems, subsystems, and equipment.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.
  - 3. Demonstration and training video recordings.

#### 1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
  - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For facilitator, instructor and videographer as applicable.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit three copies within seven days of end of each training module.
  - 1. Identification: On each copy, provide an applied label with the following information:
    - a. Name of Project.
    - b. Name and address of videographer.
    - c. Name of Engineer/Architect.
    - d. Name of Program Manager.

- e. Name of Contractor.
  - f. Date of video recording.
2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
  3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
  4. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc and uploaded to Program Manager's web-based Project Management System.

#### 1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Pre-instruction Conference: Conduct conference at Project site to review methods and procedures related to demonstration and training including, but not limited to, the following:
  1. Inspect and discuss locations and other facilities required for instruction.
  2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
  3. Review required content of instruction.
  4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

#### 1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer/Architect.

## PART 2 - PRODUCTS

### 2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  - 2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Operations manuals.
    - c. Maintenance manuals.
    - d. Project record documents.
    - e. Identification systems.
    - f. Warranties and bonds.
    - g. Maintenance service agreements and similar continuing commitments.
  - 3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.
    - c. Shutdown instructions for each type of emergency.
    - d. Operating instructions for conditions outside of normal operating limits.
    - e. Sequences for electric or electronic systems.
    - f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
  - a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
7. Maintenance: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
8. Repairs: Include the following:
  - a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

#### 3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. Engineer/Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
  - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
  - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Schedule training with Owner, through Program Manager, with at least 21 days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
- F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

#### 3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and

demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.
1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
  2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
  3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
  4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:
    - a. Name of Contractor/Installer.
    - b. Business address.
    - c. Business phone number.
    - d. Point of contact.
    - e. E-mail address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
1. Film training session(s) in segments not to exceed 15 minutes.
    - a. Produce segments to present a single significant piece of equipment per segment.
    - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.
- E. Narration: Describe scenes on video recording by dubbing audio narration off-site after video recording is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

- G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

END OF SECTION 017900



***DIVISION 2***  
***GEOTECHNICAL***

***DIVISION 2***

***SITEWORK***

***DIVISION 3***

***CONCRETE***

## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1- GENERAL

#### 1.01 SCOPE OF WORK

- A. Description of scope and intent:
1. CONTRACTOR shall provide all material, labor, and tools required to complete the installation of specified system.
  2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the CONTRACTOR of the obligation to provide same.
  3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  4. Installation shall be accomplished by workers skilled in their craft that will perform their work in a professional manner and will leave the premises safe, orderly, and clean.
  5. Drawings and general provisions of Contract, including General and Supplemental Conditions and Division 1 Specification Sections, apply to this Section.
  6. CONTRACTOR is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees, and services necessary for completion of work in this section.
- B. Section Includes:
1. Formwork for cast in place concrete, with shoring, bracing, and anchorage.
  2. Formwork accessories.
  3. Form stripping.
  4. Reinforcing steel for cast in place concrete.
  5. Cast in place concrete, including concrete for the following:
    - a. Foundations, footings.
    - b. Slabs on grade.
    - c. Supported slabs.
    - d. Foundation and structural walls.
    - e. Equipment pads and bases.
  6. Concrete curing.
  7. Shoring and reshoring.

#### 1.02 REFERENCES

All referenced standards refer to the edition in force at the time these plans and specifications are issued for bidding.

- A. AASHTO M 182 Standard Specification for Burlap Cloth Made from Jute or Kenaf; American Association of State Highway and Transportation Officials.
- B. ACI 117 Standard Tolerances for Concrete Construction and Materials; American Concrete Institute.
- C. ACI 201.2R Guide to Durable Concrete; American Concrete Institute.
- D. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and

Mass Concrete; American Concrete Institute.

- E. ACI 214 Recommended Practice for Evaluation of Compression Test Results of Field Concrete.
- F. ACI 301 Specifications for Structural Concrete for Buildings; American Concrete Institute.
- G. ACI 302.1R Guide for Concrete Floor and Slab Construction; American Concrete Institute.
- H. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute.
- I. ACI 305R Hot Weather Concreting; American Concrete Institute.
- J. ACI 306R Cold Weather Concreting; American Concrete Institute.
- K. ACI 318 Building Code Requirements for Reinforced Concrete; American Concrete Institute.
- L. ACI 347R Guide to Formwork for Concrete; American Concrete Institute.
- M. ACI 350 Concrete Sanitary ENGINEER Structures.
- N. ACI SP 66ACI Detailing Manual; American Concrete Institute.
- O. ASTM A 185 Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- P. ASTM A 615 Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- Q. ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- R. ASTM C 33 Standard Specification for Concrete Aggregates.
- S. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- T. ASTM C 42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- U. ASTM C 94 Standard Specification for Ready Mixed Concrete.
- V. ASTM C 143 Standard Test Method for Slump of Hydraulic Cement Concrete.
- W. ASTM C 150 Standard Specification for Portland Cement.

- X. ASTM C 171 Standard Specifications for Sheet Materials for Curing Concrete.
- Y. ASTM C 172 Standard Practice for Sampling Freshly Mixed Concrete.
- Z. ASTM C 173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
- AA. ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- BB. ASTM C 260 Standard Specifications for Air Entraining Admixtures for Concrete.
- CC. ASTM C 494 Standard Specifications for Chemical Admixtures for Concrete.
- DD. ASTM C 618 Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
- EE. ASTM C 685 Standard Specifications for Concrete Made by Volumetric Batching and Continuous Mixing.
- FF. ASTM C 881 Standard Specification for Epoxy Resin Base Bonding Systems for Concrete.
- GG. ASTM C 1059 Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
- HH. ASTM C 1107 Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).
- II. ASTM D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- JJ. ASTM D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- KK. ASTM E 154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth under Concrete Slabs, on Walls, or as Ground Cover.
- LL. ASTM E 329 Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- MM. CRSI Manual of Standard Practice; Concrete Reinforcing Steel Institute.
- NN. Florida Building Code – FBC

### 1.03 DEFINITIONS

- A. Unexposed Finish: A general use finish, with no appearance criteria, applicable to all formed

concrete concealed from view after completion of construction.

- B. Exposed Finish: A general use finish applicable to all formed concrete exposed to view except those indicated to receive textured finish, and including surfaces which may receive a paint coating (if any).

#### 1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for the following:
  - 1. Formwork accessories.
  - 2. Form liners.
  - 3. Concrete admixtures.
  - 4. Grout.
  - 5. Bonding compound.
  - 6. Epoxy bonding system
- B. Aggregates: Submit test reports showing compliance with specified quality and gradation.
- C. Shop Drawings: Submit shop drawings for fabrication and placement of the following:
  - 1. Reinforcement: Comply with ACI SP 66. Include bar schedules, diagrams of bent bars, arrangement of concrete reinforcement, and splices.
    - a. Show construction joints.
    - b. Include details of reinforcement at openings through concrete structures.
    - c. Include elevations of reinforcement in walls.
    - d. Show stirrup spacing.
    - e. Concrete embedments.
  - 2. Shoring and reshoring for elevated concrete placement shall include:
    - a. Location, size, and type of all shoring members.
    - b. Location, size, and type of all reshoring members.
    - c. Location, size, and type of all mud sills, blocking, temporary lateral bracing and other accessories necessary to safely support and brace the structure during construction.
    - d. Prepare shop drawings under seal of professional structural ENGINEER registered in the state of Florida.
- D. Quality Control Submittals
  - 1. Submit the following information related to quality assurance requirements specified:
  - 2. Design data: Submit proposed mix designs and test data before concrete operations begin. Identify for each mix submitted the method by which proportions have been selected.
    - a. For mix designs based on trial mixtures, include trial mix proportions, test results, and graphical analysis and show required average compressive strength  $f'(cr)$ .
    - b. Indicate quantity of each ingredient per cubic yard of concrete.
    - c. Indicate type and quantity of admixtures proposed or required.
  - 3. Test reports: Submit laboratory test reports for all testing specified.
  - 4. Certifications: Submit affidavits from an independent testing agency certifying that all materials furnished under this section conform to specifications.
  - 5. Certifications: Provide certification from manufacturers of concrete admixtures that chloride content complies with specified requirements.
  - 6. Certifications: Submit mill test certificates for all reinforcing steel furnished under this

- section, showing physical and chemical analysis.
7. Placement schedule: Submit concrete placement schedule prior to start of any concrete placement operations. Include location of all joints indicated on drawings, plus anticipated construction joints.
  8. Submit batch tickets complying with ASTM C 685 or delivery tickets complying with ASTM C 94, as applicable, for each load of concrete used in the work.
    - a. Include on the tickets the additional information specified in the ASTM document.
  9. Cold weather concreting: Submit description of planned protective measures.
  10. Hot weather concreting: Submit description of planned protective measures.

#### 1.05 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the following documents, except where requirements of the contract documents or of governing codes and governing authorities are more stringent:
  1. ACI 301
  2. ACI 318
  3. ACI 350
  4. CRSI Manual of Standard Practice.
- B. Testing Agency Services:
  1. Employ, at CONTRACTOR's expense, an independent testing agency acceptable to the ENGINEER to perform specified tests and other services required for quality assurance.
    - a. Testing agency shall meet ASTM E 329 requirements.
- C. Source of Materials: Obtain materials of each type from same source for the entire project.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver reinforcement to project site bundled and tagged with metal tags indicating bar size, lengths, and other data corresponding to information shown on placement drawings.
  1. Concrete reinforcement materials stored on the site shall be kept on concrete blocks and supported off the ground to prevent damage and accumulation of water, dirt, or rust.
- B. Store cementitious materials in a dry, weather tight location. Maintain accurate records of shipment and use.
- C. Store aggregates to permit free drainage and to avoid contamination with deleterious matter or other aggregates. When stockpiled on ground, discard bottom 6 inches of pile.
- D. Handle aggregates to avoid segregation.

#### 1.07 PROJECT CONDITIONS

- A. Cold Weather Concreting: Comply fully with the recommendations of ACI 306.
  1. Well in advance of proposed concreting operations, advise the ENGINEER of planned protective measures including but not limited to heating of materials, heated enclosures, and insulating blankets.



- B. Hot Weather Concreting: Comply fully with the recommendations of ACI 05R.
  - 1. Well in advance of proposed concreting operations, advise the ENGINEER of planned protective measures including but not limited to cooling of materials before or during mixing, placement during evening to dawn hours, fogging during finishing and curing, shading, and windbreaks.

## PART 2- PRODUCTS

### 2.01 FORMWORK

- A. Facing Materials:
  - 1. Unexposed finish concrete: Any standard form materials that produce structurally sound concrete.
  - 2. Exposed finish concrete: Materials selected to offer optimum smooth, stain free final appearance and minimum number of joints. Provide materials with sufficient strength to resist hydrostatic head without bow or deflection in excess of allowable tolerances.
  - 3. Textured finish concrete: Materials or linings as indicated on the drawings, or as required to match ENGINEER's control sample.
- B. Formwork Accessories:
  - 1. Form coating: Form release agent that will not adversely affect concrete surfaces or prevent subsequent application of concrete coatings.
  - 2. Metal ties: Commercially manufactured types; cone snap ties, taper removable bolt, or other type which will leave no metal closer than 1-1/2 inches from surface of concrete when forms are removed, leaving not more than a 1-inch diameter hole in concrete surface.
  - 3. Fillets: Wood or plastic fillets for chamfered corners, in maximum lengths possible.

### 2.02 REINFORCING MATERIALS

- A. Reinforcing Bars: Provide deformed bars complying with the following, except where otherwise indicated:
  - 1. ASTM A 615, Grade 60.
- B. Welded Wire Fabric: ASTM A 185, cold drawn steel, plain.
- C. Reinforcing Accessories:
  - 1. Tie wire: Black annealed type, 16 1/2 gage or heavier.
  - 2. Supports: Bar supports conforming to specifications of CRSI "Manual of Standard Practice."
    - a. Class 1 (plastic protected) at all formed surfaces which will be exposed to weather.
    - b. Class 1 (plastic protected) or Class 2 (stainless steel protected) at all formed surfaces which will be exposed to view but not to weather.
    - c. Precast concrete blocks of strength equal to or greater than specified strength of concrete or Class 3 supports equipped with sand plates, where concrete will be cast against earth. Concrete masonry units will not be accepted.

### 2.03 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, and as follows:

1. Type I, except where other type is specifically permitted or required.
  2. Type II shall be used for moderate sulfate resistance, retaining walls and exposed concrete not included in Type V below and when hot weather concreting is required.
  3. Type III shall be used for high early strength and when cold weather concreting is required.
  4. Type IV shall be used for low heat of hydration when mass concreting is required.
  5. Type V shall be used for high sulfate resistance and in all environmental (includes all wet well surfaces) and all liquid retaining structures.
- B. Fly Ash: ASTM C 618, Type C or F.
- C. Water: Potable.
- D. Aggregates:
1. Normal weight concrete: ASTM C 33.
    - a. Class 5M.
    - b. Gradation as specified below under mix design.
- E. Admixtures General: Admixtures which result in more than 0.1 percent of soluble chloride ions by weight of cement are prohibited.
- F. Air Entraining Admixture: ASTM C 260 and certified by manufacturer for compatibility with other mix components.
1. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:
    - a. "Air Mix"; The Euclid Chemical Company.
    - b. "Sika Aer"; Sika Corporation.
    - c. "Micro Air"; Master Builders, Inc.
    - d. "Darex AEA"; W. R. Grace & Co.
- G. Water Reducing, Retarding Admixture: ASTM C 494, Type D.
1. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:
    - a. "Pozzolite Retarder"; Master Builders, Inc.
    - b. "Eucon Retarder 75"; The Euclid Chemical Company.
    - c. "Daratard 17"; W. R. Grace & Co.
    - d. "PSI R Plus"; Cormix Construction Chemicals.
    - e. "Plastiment"; Sika Corporation.
    - f. "Protard"; Master Builders, Inc. (former Conchem product).
- H. Water Reducing and Accelerating Admixtures: ASTM C 494, Type E.
1. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:
    - a. "Accelguard 80"; The Euclid Chemical Company.
    - b. "Pozzutec 20"; Master Builders, Inc.
    - c. "Gilco Accelerator"; Cormix Construction Chemicals.
- I. High Range Water Reducing Admixture (Superplasticizer): ASTM C 494, Type F or G.
1. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:

- a. "WRDA 19" or "Daracem 100"; W. R. Grace & Co.
  - b. "PSP Superplasticizer"; Master Builders, Inc. (former Conchem product).
  - c. "Sikament 300"; Sika Corporation.
  - d. "Eucon 37"; The Euclid Chemical Company.
  - e. "PSI Super"; Cormix Construction Chemicals.
  - f. "Rheobuild"; Master Builders, Inc.
- J. Crystalline Concrete Waterproofing Admixture: Refer to 07147 – Crystalline Concrete Waterproofing

## 2.04 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Vapor Retarder: Membrane for installation beneath slabs on grade, resistant to decay when tested in accordance with ASTM E 154, and as follows:
1. Polyethylene sheet, not less than 8 mils thick.
- B. Nonshrink Grout: ASTM C 1107.
1. Type: Provide nonmetallic type only.
  2. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:
    - a. Nonmetallic type:
      - 1) "Masterflow 928"; Master Builders, Inc.
      - 2) "SonogROUT 14k"; Sonneborn Building Products Division ChemRex, Inc.
      - 3) "Euco N S Grout"; The Euclid Chemical Company.
      - 4) "Supreme"; Cormix Construction Chemicals.
      - 5) "Five Star Grout"; Five Star Products, Inc.
- C. Burlap: AASHTO M 182, Class 2 jute or kenaf cloth.
- D. Moisture Retaining Cover: ASTM C 171, and as follows:
1. Curing paper.
  2. Polyethylene film.
  3. White burlap polyethylene sheeting.
- E. Bonding Compound: Non redispersable acrylic bonding admixture, ASTM C 1059, Type II.
1. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:
    - a. "Everbond"; L & M Construction Chemicals, Inc.
    - b. "Flex Con"; The Euclid Chemical Company.
- F. Epoxy Bonding Systems: Epoxy adhesive for bonding fresh concrete to hardened concrete and for grouting wall pipes, bolts and reinforcing dowels. ASTM C 881; type, grade, and class as required for project conditions.
1. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:
    - a. "Concresive LPL"; Master Builders, Inc.
    - b. "Sikadur 32 Hi Mod"; Sika Corporation.
    - c. "Euco #452 Epoxy System"; The Euclid Chemical Company.
    - d. "Sikastix 390".
    - e. "EucoEpoxy 461".
    - f. "Five Star Epoxy Grout".

- g. "Sikstix 370".
- h. "EucoEpoxy 463".

G. Expansion Joint Filler

1. Expansion Joint Filler shall be performed non-extruding and resilient type meeting the Specifications of ASTM D1751, or D1752, unless otherwise specified.
2. All expansion joints in base slabs on grade other than hydraulic structures shall be fiber expansion joints of required slab depth meeting the requirement of ASTM D1751, Type I and AASHTO M213. Exposed joints shall be sealed as specified below.
3. All expansion joints in hydraulic structures shall be ¾ inch sponge rubber expansion joints of required wall thickness meeting the requirements of ASTM D1752, Type I and AASHTO M153, Type I. Joints shall be sealed on both sides as specified below.
  - a. Nonextruding bituminous type: ASTM D 1751.
  - b. Sponge rubber type: ASTM D 1752, Type I.

H. Expansion Joint Sealer

1. Joint sealants for hydraulic structures shall be one of the following, or approved equal:
  - a. "CM-60" two-part gray tone, as manufactured by W. R. Meadows, Inc., applied over a backer rod sized for the joint. Underwater primer shall be used on all joints subject to immersion. Standard "CM-60" primer shall be applied to all other joints. Sealant depth shall be one-half the width of the joint.
  - b. The sealant shall be a two-part, polyurethane sealant "Eucolastic I" by the Euclid Chemical Company or "Sikaflex 1a" by Sika Chemical Company. Joint width should be 4 times the expected joint movement, but not less than ¼ inch. All joints shall be primed with "Eucolastic Primer" by the Euclid Chemical Company or "Sikaflex 429" by Sika Chemical Company.

I. PVC Waterstops

Waterstops: Made of Polyvinyl Chloride (PVC) and of subzero grade, Plastigrip, Type W-6 as manufactured by Progress Unlimited, Inc. or approved equivalent.

1. Minimum 4" x 3/16" or as specified on the drawings.
2. Produced from a compound, the base resin of which shall be virgin PVC.
3. Minimum Properties:
  - a. 2000 psi minimum tensile strength, ASTM D412-51T
  - b. 350% minimum elongation, ASTM D412-51T
  - c. -35 degrees F minimum low temperature brittleness, ASTM D746-57T
  - d. 65-75 shore 'A' durometer hardness, ASTM D676-59T
  - e. 0.15 maximum water absorption, ASTM D570-59T
4. Field Splicing:
  - a. Butt splices shall be fused welded using a thermostatically controlled Teflon PVC Waterstop iron at the Manufacturer's recommended temperature
  - b. Lapping, gluing or use of adhesives shall not be permitted.
  - c. Provide factory made waterstop fabrications for all changes of directions, intersections, and transitions leaving only butt joint splicing for the field.
5. Center waterstop in the joint and secure in correct position.
6. Use ribbed center bulb for all moving joints. Use dumbbell for all non-movement joints.
7. Always place the center bulb in the center of the expansion joint. Do not embed the center bulb in concrete.
8. Vibrate concrete around waterstops thoroughly to prevent honeycombing and to ensure contact between concrete and waterstop.

## 2.05 CONCRETE MIX DESIGN

- A. Review: Do not begin concrete operations until proposed mix has been reviewed by the ENGINEER.
- B. Proportioning of Normal Weight Concrete: Comply with recommendations of ACI 211.1.
- C. Required Average Strength: Establish the required average strength  $f_{cr}$  of the design mix on the basis of trial mixtures as specified in ACI 301, and proportion mixes accordingly. Employ an independent testing agency acceptable to the ENGINEER for preparing and reporting proposed mix design.
- D. Proportion normal-weight concrete mix to produce an average strength at 28 day as follows unless otherwise indicated on the drawings:
  - 1. Columns, beams, walls, footings, and slabs: 4000 psi
  - 2. Masonry Filled Grout: 3000 psi
  - 3. Prestressed Elements: 5000 psi
- E. Fly Ash:
  - 1. The CONTRACTOR may elect to replace a portion of the Portland cement with fly ash up to a maximum of 25 percent by weight of cement plus fly ash.
- F. Admixtures:
  - 1. Air entraining admixture: Add at rate to achieve specified air content.
    - a. Do not use in slabs on grade scheduled to receive topping, unless manufacturer of topping recommends use over air entrained concrete.
  - 2. Water reducing and retarding admixture: Add as required in concrete mixes to be placed at ambient temperatures above 90 degrees F.
  - 3. Water reducing and accelerating admixture: Add as required in concrete mixes to be placed at ambient temperatures below 50 degrees F.
  - 4. High range water reducing admixture (superplasticizer): Add as required for placement and workability.
  - 5. Do not use admixtures not specified or approved.
- G. Design mix to meet or exceed each requirement specified. Where more than one criterion is specified, the most stringent shall apply. For example, a minimum cement content or maximum water cement ratio might result in strengths greater than the minimum specified; likewise, a greater cement content or lower water cement ratio may be required in order to achieve the required strength.
  - 1. Specified compressive strength  $f_c$  (ASTM C 39): As noted
  - 2. Maximum water cement ratio by weight:
    - a. 0.4 for concrete toppings subject to traffic
    - b. 0.45 for all other concrete
  - 3. Maximum slump: As recommended in ACI 211.1. and ACI 350 as applicable.
  - 4. Gradation of coarse aggregate: ASTM C 33 standard gradation with maximum nominal size of 3/4 inches.
  - 5. Total air content (ASTM C 173 or ASTM C 231): 5 percent.
- H. Mix Adjustments: Provided that no additional expense to OWNER is involved,

CONTRACTOR may submit for ENGINEER's approval requests for adjustment to approved concrete mixes when circumstances such as changed project conditions, weather, or unfavorable test results occur. Include laboratory test data substantiating specified properties with mix adjustment requests.

## 2.06 CONTROL OF MIX IN THE FIELD

- A. Slump: A tolerance of up to 1 inch above that specified will be permitted for 1 batch in 5 consecutive batches tested. Concrete of lower slump than that specified may be used, provided proper placing and consolidation is obtained.
  - 1. If slump upon arrival at the site is lower than 1 inch below the value specified, one addition of water in accordance with ASTM C 94 will be permitted to bring slump within tolerance, provided that:
    - a. A positive means is available to measure the amount of water added at the site.
    - b. The specified (or approved) maximum water cement ratio is not exceeded.
    - c. Not more than 45 minutes have elapsed since batching.
- B. Total Air Content: A tolerance of plus or minus 1 1/2 percent of that specified will be allowed for field measurements.
- C. Do not use batches that exceed tolerances.

## 2.07 CONCRETE MIXING

- A. On Site Equipment: Mix concrete materials in appropriate drum type batch machine mixer, in compliance with ASTM C 685. Mix each batch minimum of 1 1/2 minutes and maximum of 5 minutes before discharging concrete. Clean thoroughly at end of day and before changing concrete type.
- B. Transit Mixers: Mix concrete materials in transit mixers, complying with requirements of ASTM C 94.
  - 1. At ambient temperatures of 85 to 90 degrees F, reduce mixing and delivery time to 75 minutes.
  - 2. At ambient temperatures above 90 degrees F, reduce mixing and delivery time to 60 minutes.

## PART 3- EXECUTION

### 3.01 CONCRETE FORM PREPARATION

- A. General: Comply with requirements of ACI 301 for formwork, and as herein specified. The CONTRACTOR is responsible for design, ENGINEER, and construction of formwork, and for its timely removal.
- B. Earth Forms: Hand trim bottoms and sides of earth forms to profiles indicated on the drawings. Remove loose dirt before placing concrete.
- C. Design: Design and fabricate forms for easy removal, without impact, shock, or damage to concrete surfaces or other portions of the work. Design to support all applied loads until concrete is adequately cured, within allowable tolerances and deflection limits.
- D. Construction: Construct and brace formwork to accurately achieve end results required by

contract documents, with all elements properly located and free of distortion. Provide for necessary openings, inserts, anchorages, and other features shown or otherwise required.

1. Joints: Minimize form joints and make watertight to prevent leakage of concrete.
    - a. Align joints symmetrically at exposed conditions.
  2. Chamfers: Provide chamfered edges and corners at exposed locations, unless specifically indicated otherwise on the drawings.
  3. Permanent openings: Provide openings to accommodate work of other trades, sized and located accurately. Securely support items built into forms; provide additional bracing at openings and discontinuities in formwork.
  4. Temporary openings: Provide temporary openings for cleaning and inspection in most inconspicuous locations at base of forms, closed with tight fitting panels designed to minimize appearance of joints in finished concrete work.
- E. Tolerances for Formed Surfaces: Comply with minimum tolerances established in ACI 117, unless more stringent requirements are indicated on the drawings.
- F. Release Agent: Provide either form materials with factory applied non-absorptive liner or field applied form coating. If field applied coating is employed, thoroughly clean and recondition formwork and reapply coating before each use. Rust on form surfaces is unacceptable.

### 3.02 VAPOR RETARDER INSTALLATION

- A. General: Place vapor retarder sheet over prepared base material, aligning longer dimension parallel to direction of pour and lapped 6 inches. Seal joints with appropriate tape. Cover with sand to depth shown on drawings.

### 3.03 PLACING REINFORCEMENT

- A. General: Comply with requirements of ACI 301 and as herein specified.
- B. Preparation: Clean reinforcement of loose rust and mill scale, soil, and other materials which adversely affect bond with concrete.
- C. Placement: Place reinforcement to achieve not less than minimum concrete coverages required for protection. Accurately position, support, and secure reinforcement against displacement. Provide Class C tension lap splices complying with ACI 318 unless otherwise indicated. Do not field bend partially embedded bars unless otherwise indicated or approved.
  1. Use approved bar supports and tie wire, as required. Set wire ties to avoid contact with or penetration of exposed concrete surfaces. Tack welding of reinforcing is not permitted.
  2. Wire fabric: Install in maximum lengths possible, lapping adjoining pieces not less than one full mesh. Offset end laps to prevent continuous laps in either direction and splice laps with tie wire.
- D. Welding: Welding of reinforcement is not permitted.

### 3.04 JOINT CONSTRUCTION

- A. Construction Joints: Locate and install construction joints as indicated on drawings. If construction joints are not indicated, locate in manner which will not impair strength and will

have least impact on appearance, as acceptable to the ENGINEER. Construction joints in retaining walls and walls of concrete tanks or structures subject to hydrostatic pressure shall be intentionally roughened to a full amplitude of approximately ¼ inch.

1. Keyways: Provide keyways not less than 1 1/2 inches deep.
  2. Reinforcement: Continue reinforcement across and perpendicular to construction joints, unless details specifically indicate otherwise.
- B. Isolation Joints: Construct isolation joints in slabs poured on grade at points of contact with vertical components, such as foundation walls and column pedestals. Install expansion joint filler to full concrete depth. Recess top edge of filler 1/8 inch where joints are unsealed.
- C. Expansion Joints: Construct expansion joints where indicated. Install expansion joint filler to full depth of concrete. Recess edge of filler to depth indicated to receive joint sealant and backer rod as specified herein and detailed on drawings.
- D. Control Joints: Construct contraction joints in building slabs poured on grade to form panels of sizes indicated on drawings, but not more than 20 feet apart in either direction.
1. Saw cuts: Form control joints by means of saw cuts one fourth the depth of the slab, performed as soon as possible after slab finishing without dislodging aggregate.

### 3.05 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set anchorage devices and other items required for other work connected to or supported by cast in place concrete, using templates, setting drawings, and instructions from suppliers of items to be embedded.
1. Edge Forms and Screeds: Set edge forms and intermediate screeds as necessary to achieve final elevations indicated for finished slab surfaces.

### 3.06 WATERSTOPS

- A. Waterstops shall be provided at all joints to seal off leakage of liquid from or into concrete tanks or structures subject to hydrostatic pressures. The type of waterstops used shall be as shown on the Drawings and as specified herein. The CONTRACTOR shall submit to the ENGINEER for approval the proposed procedure and schedule of his concrete placing operations along with a detailed layout of the waterstop materials required showing sizes, lengths, and types of joints.
- B. Where required for proper location of waterstops, whether shown on the Drawings or not, starter walls of up to 1-1/2 inches in height and monolithic with slabs shall be provided at all wall construction joints. Reinforcing steel shall not be depressed at waterstops but shall have only the amount of concrete covering shown or specified. Starter walls as specified shall be required whether shown on the Drawings or not, unless specified concrete cover over reinforcing steel is 3 inches or greater.

### 3.07 CONCRETE PLACEMENT

- A. Preparation: Provide materials necessary to ensure adequate protection of concrete during inclement weather before beginning installation of concrete.
- B. Inspection: Before beginning concrete placement, inspect formwork, reinforcing steel, and items to be embedded, verifying that all such work has been completed.



1. Wood forms: Moisten immediately before placing concrete in locations where form coatings are not used.
- C. Placement General: Comply with requirements of ACI 304 and as follows:
1. Concreting should be carried on at such a rate that the concrete is at all times plastic and flows readily into spaces between reinforcement.
  2. Schedule continuous placement of concrete to prevent the formation of cold joints.
  3. Provide construction joints if concrete for a particular element or component cannot be placed in a continuous operation.
  4. Deposit concrete as close as possible to its final location, to avoid segregation.
  5. Concrete shall be worked around reinforcement and embedded fixtures and into corners of forms.
  6. The following shall be prohibited from use:
    - a. Partially hardened concrete.
    - b. Contaminated concrete.
    - c. Re-tempered concrete.
    - d. Re-mixed concrete after initial set has occurred.
- D. Placement in Forms: Limit horizontal layers to depths which can be properly consolidated, but in no event greater than 24 inches.
1. Consolidate concrete by means of mechanical vibrators, inserted vertically in freshly placed concrete in a systematic pattern at close intervals. Penetrate previously placed concrete to ensure that separate concrete layers are knitted together.
  2. Vibrate concrete sufficiently to achieve consistent consolidation without segregation of coarse aggregates.
  3. Do not use vibrators to move concrete laterally.
- E. Slab Placement: Schedule continuous placement and consolidation of concrete within planned construction joints.
1. Thoroughly consolidate concrete without displacing reinforcement or embedded items, using internal vibrators, vibrating screeds, roller pipe screeds, or other means acceptable to ENGINEER.
  2. Strike off and level concrete slab surfaces, using highway straightedges, darbies, or bull floats before bleed water can collect on surface. Do not work concrete further until finishing operations are commenced.
- F. Cold Weather Placement: Comply with recommendations of ACI 306 when air temperatures are expected to drop below 40 degrees F either during concrete placement operations or before concrete has cured.
1. Do not use frozen or ice laden materials.
  2. Do not place concrete on frozen substrates.
- G. Hot Weather Placement: Comply with recommendations of ACI 305R when ambient temperature before, during, or after concrete placement is expected to exceed 90 degrees F or when combinations of high air temperature, low relative humidity, and wind speed are such that the rate of evaporation from freshly poured concrete would otherwise exceed 0.2 pounds per square foot per hour.
1. Do not add water to approved concrete mixes under hot weather conditions.
  2. Provide mixing water at lowest feasible temperature, and provide adequate protection of poured concrete to reduce rate of evaporation.
  3. Use fog nozzle to cool formwork and reinforcing steel immediately prior to placing

concrete.

### 3.08 FINISHING FORMED SURFACES

- A. Repairs, General: Repair surface defects, including tie holes, immediately after removing formwork.
  - 1. Remove honeycombed areas and other defective concrete down to sound concrete, cutting perpendicular to surface or slightly undercutting. Dampen patch location and area immediately surrounding it prior to applying bonding compound or patching mortar.
  - 2. Before bonding compound has dried, apply patching mixture matching original concrete in materials and mix except for omission of coarse aggregate, and using a blend of white and normal portland cement as necessary to achieve color match. Consolidate thoroughly and strike off slightly higher than surrounding surface.
- B. Textured Form Finish: Repair tie holes and patch defective areas to match pattern created by form construction or form liners.
- C. Unexposed Form Finish: Repair tie holes and patch defective areas. Rub down or chip off fins or other raised areas exceeding 1/4 inch height.
- D. Exposed Form Finish: Repair and patch defective areas, with fins or other projections completely removed and smoothed.
  - 1. Smooth rubbed finish: Apply to surfaces indicated no later than 24 hours after form removal.
    - a. Wet concrete surfaces to be finished and rub with Carborundum brick or other abrasive until uniform color and texture are achieved.
    - b. Do not apply separate grout mixture.
  - 2. Contiguous unformed surfaces: Strike smooth and float to a similar texture tops of walls, horizontal offsets, and other unformed surfaces adjacent to or contiguous with formed surfaces. Continue final finish of formed surfaces across unformed surfaces, unless otherwise specifically indicated.

### 3.09 FINISHING SLABS

- A. Finishing Operations General:
  - 1. Do not directly apply water to slab surface or dust with cement.
  - 2. Use hand or powered equipment only as recommended in ACI 302.1R.
  - 3. Screeding: Strike off to required grade and within surface tolerances indicated. Verify conformance to surface tolerances. Correct deficiencies while concrete is still plastic.
  - 4. Bull Floating: Immediately following screeding, bull float or darby before bleed water appears to eliminate ridges, fill in voids, and embed coarse aggregate. Recheck and correct surface tolerances.
  - 5. Do not perform subsequent finishing until excess moisture or bleed water has disappeared and concrete will support either foot pressure with less than 1/4 inch indentation or weight of power floats without damaging flatness.
  - 6. Final floating: Float to embed coarse aggregate, to eliminate ridges, to compact concrete, to consolidate mortar at surface, and to achieve uniform, sandy texture. Recheck and correct surface tolerances.
- B. Coordinate appearance and texture of required final finishes with the ENGINEER before

application.

1. Apply final finishes in the locations indicated on the drawings.
- C. Float Finish: As specified above.
- D. Broomed Float Finish: After floating and when water sheen has practically disappeared, apply uniform transverse corrugations approximately 1/16 inch deep, without tearing surface.
- E. Slab Surface Tolerances:
1. Achieve flat, level planes except where grades are indicated. Slope uniformly to drains.
  2. Floated finishes: Depressions between high spots shall not exceed 5/16 inch under a 10 foot straightedge.
- F. Repair of Slab Surfaces: Test slab surfaces for smoothness and to verify surface plane to tolerance specified. Repair defects as follows:
1. High areas: Correct by grinding after concrete has cured for not less than 14 days.
  2. Low areas: Immediately after completion of surface finishing operations, cut out low areas and replace with fresh concrete. Finish repaired areas to blend with adjacent concrete. Proprietary patching compounds may be used when approved by the ENGINEER.
  3. Crazed or cracked areas: Cut out defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts. Dampen exposed concrete and apply bonding compound. Mix, place, compact, and finish patching concrete to match adjacent concrete.
  4. Isolated cracks and holes: Groove top of cracks and cut out holes not over 1 inch in diameter. Dampen cleaned concrete surfaces and apply bonding compound; place dry pack or proprietary repair compound acceptable to ENGINEER while bonding compound is still active:
    - a. Dry pack mix: One part Portland cement to 2-1/2 parts fine aggregate and enough water as required for handling and placing.
    - b. Install patching mixture and consolidate thoroughly, striking off level with and matching surrounding surface. Do not allow patched areas to dry out prematurely.

### 3.10 CONCRETE CURING AND PROTECTION

- A. General:
1. Prevent premature drying of freshly placed concrete, and protect from excessively cold or hot temperatures until concrete has cured.
  2. Provide curing of concrete by one of the methods listed and as appropriate to service conditions and type of applied finish in each case.
- B. Curing Period:
1. Not less than 7 days for standard cements and mixes.
  2. Not less than 4 days for high early strength concrete using Type III cement.
- C. Curing Temperature:
1. Concrete shall be maintained above 50 degrees F and in moist condition during the entire curing period.

- D. Formed Surfaces: Cure formed concrete surfaces by moist curing with forms in place for full curing period.
  - 1. Keep wooden or metal forms moist when exposed to heat of the sun.
  - 2. If forms are removed prior to completion of curing process, continue curing by one of the applicable methods specified.
  
- E. Surfaces Not in Contact with Forms:
  - 1. Start initial curing as soon as free water has disappeared, but before surface is dry.
  - 2. Keep continuously moist for not less than 3 days by uninterrupted use of any of the following:
    - a. Water ponding.
    - b. Water saturated sand.
    - c. Water fog spray.
    - d. Saturated burlap: Provide 4 inch minimum overlap at joints.
  - 3. Begin final curing procedures immediately following initial curing and before concrete has dried.
    - a. Moisture retaining cover: Lap not less than 3 inches at edges and ends, and seal with waterproof tape or adhesive. Repair holes or tears during curing period with same tape or adhesive. Maintain covering in intimate contact with concrete surface. Secure to avoid displacement.
      - 1) Extend covering past slab edges at least twice the thickness of slab.
      - 2) Do not use plastic sheeting on surfaces which will be exposed to view when in service.
      - 3) Continue final curing to end of curing period.
  
- F. Avoid rapid drying at end of curing period.
  
- G. During and following curing period, protect concrete from temperature changes of adjacent air in excess of 5 degrees F per hour and 50 degrees F per 24 hours. Progressively adjust protective measures to provide uniform temperature changes over entire concrete surface.

### 3.11 SHORES AND SUPPORTS

- A. General: Comply with recommendations of ACI 347 for shoring and reshoring in multistory construction.
  
- B. Low Rise Construction: Extend shoring from ground to roof for structures 4 stories or less in height.
  
- C. Reshoring: Remove shores and reshore in a planned sequence, to avoid damage to partly cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.
  
- D. Provide as a package, shoring and reshoring drawings prepared by or under the direct supervision of a specialty ENGINEER registered in the State of Florida.

### 3.12 REMOVAL OF FORMS AND SUPPORTS

- A. Non Load Bearing Formwork: Provided that concrete has hardened sufficiently that it will not be damaged, forms not actually supporting weight of concrete or weight of soffit forms

may be removed after concrete has cured at not less than 50 degrees F for 24 hours. Maintain curing and protection operations after form removal.

- B. Load Bearing Formwork: Do not remove shoring and forms supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, until concrete has attained at least the specified compressive strength  $f'(c)$  and until the CONTRACTOR has determined that the actual compressive strength attained is adequate to support the weight of the concrete and superimposed loads.
- C. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained at least the specified compressive strength  $f'(c)$  and until the CONTRACTOR has determined that the actual compressive strength attained is adequate to support the weight of the concrete and superimposed loads.
- D. Keep supports in place until heavy loads due to construction operations have been removed.
- E. Test field cured specimens to determine potential compressive strength of concrete for specific locations.

### 3.13 MISCELLANEOUS CONCRETE ITEMS

- A. Fill in: Fill in holes and openings left in concrete structures for passage of work by other trades after such work is in place. Place such fill in concrete to blend with existing construction, using same mix and curing methods.
- B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as indicated on drawings. Set anchor bolts at correct elevations, complying with diagrams or templates of equipment manufacturer.
  - 1. Grout base plates and foundations as indicated with non-shrink grout.
  - 2. Use nonmetallic grout for exposed conditions, unless otherwise indicated.
- C. Reinforced Masonry: Provide concrete grout for reinforced masonry where indicated on drawings and as scheduled.

### 3.14 CONCRETE REPAIRS

- A. General: Repairs due to poor workmanship shall be made by the CONTRACTOR at the CONTRACTOR's expense and shall be approved by the ENGINEER prior to repair procedure being implicated.
- B. Perform cosmetic repairs of concrete surfaces as specified under concrete application.
- C. Perform structural repairs with prior approval of the ENGINEER for method and procedure, using epoxy bonding systems. The ENGINEER's approval is required for repair methods using materials other than those specified.

### 3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. Refer to Section 01410 for additional concrete testing requirements for the project.

- B. Composite Sampling, and Making and Curing of Specimens: ASTM C 172 and ASTM C 31.
  - 1. Take samples at point of discharge.
  - 2. For pumped concrete, perform sampling and testing at the frequencies specified herein at point of delivery to pump, and perform additional sampling and testing at the same frequency at discharge from line.
  - 3. Results obtained at discharge from line shall be used for acceptance of concrete.
  
- C. Slump: ASTM C 143. One test per strength test and additional tests if concrete consistency changes.
  - 1. Modify sampling to comply with ASTM C 94.
  
- D. Air Content of Normal Weight Concrete: ASTM C 173 or ASTM C 231. One test per strength test performed on air entrained concrete.
  
- E. Concrete Temperature:
  - 1. Test hourly when air temperature is 40 degrees F or below.
  - 2. Test hourly when air temperature is 90 degrees F or above.
  - 3. Test each time a set of strength test specimens is made.
  
- F. Compressive Strength Tests: ASTM C 39.
  - 1. Compression test specimens: Mold and cure one set of 4 standard cylinders for each compressive strength test required.
  - 2. Testing for acceptance of potential strength of as delivered concrete:
    - a. Obtain samples on a statistically sound, random basis.
    - b. Minimum frequency:
      - 1) One set per 100 cubic yards or fraction thereof for each day's pour of each concrete class.
      - 2) One set per 3500 square feet of slab or wall area or fraction thereof for each day's pour of each concrete class.
      - 3) When the above testing frequency would provide fewer than 5 strength tests for a given class of concrete during the project, conduct testing from not less than 5 randomly selected batches, or from each batch if fewer than 5.
    - c. Test one specimen per set at 7 days for information unless an earlier age is required.
    - d. Test 2 specimens per set for acceptance of strength potential; test at 28 days unless other age is specified. The test result shall be the average of the two specimens. If one specimen shows evidence of improper sampling, molding, or testing, the test result shall be the result of the remaining specimen; if both show such evidence, discard the test result and inform the ENGINEER.
    - e. Retain one specimen from each set for later testing, if required.
    - f. Strength potential of as delivered concrete will be considered acceptable if all of the following criteria are met:
      - 1) No individual test result falls below specified compressive strength by more than 500 psi.
      - 2) Average of any 3 consecutive strength test results equals or exceeds specified compressive strength  $f'_c$ .
      - 3) Testing for evaluation of field curing:
        - a) Frequency: 1 field set of specimens per strength acceptance test.
        - b) Mold specimens from same sample used for strength acceptance tests. Field cure, and test at same age as for strength acceptance tests.

- c) Evaluate construction and curing procedures and implement corrective action when strength results for field cured specimens are less than 85 percent of test values for companion laboratory cured specimens.
  3. Removal of forms or supports: Mold additional specimens and field cure with concrete represented; test to determine strength of concrete at proposed time of form or support removal.
- G. Test Results: Testing agency shall report test results in writing to ENGINEER and CONTRACTOR within 24 hours of test.
  1. Test reports shall contain the following data:
    - a. Project name, number, and other identification.
    - b. Name of concrete testing agency.
    - c. Date and time of sampling.
    - d. Concrete type and class.
    - e. Location of concrete batch in the completed work.
    - f. All information required by respective ASTM test methods.
  2. Nondestructive testing devices such as impact hammer or sonoscope may be used at ENGINEER's option for assistance in determining probable concrete strength at various locations or for selecting areas to be cored, but such tests shall not be the sole basis for acceptance or rejection.
  3. The testing agency shall make additional tests of in place concrete as directed by the ENGINEER when test results indicate that specified strength and other concrete characteristics have not been attained.
    - a. Testing agency may conduct tests of cored cylinders complying with ASTM C 42, or tests as directed.
    - b. Cost of additional testing shall be borne by the CONTRACTOR when unacceptable concrete has been verified.

END OF SECTION 033000

033100 – CONCRETE SEALER

PART 1 - GENERAL

1.01 SUMMARY

- A. Description of scope and intent:
  - 1. CONTRACTOR shall provide all material, labor, and tools required to complete the installation of specified system.
  - 2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the DESIGN-BUILDER of the obligation to provide same.
  - 3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  - 4. Installation shall be accomplished by workers skilled in their craft who will perform their work in a professional manner and will leave the premises safe, orderly and clean.
  - 5. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section
  - 6. CONTRACTOR is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees and services necessary for completion of work in this section.
  - 7. In the event of a conflict between the design drawings, referenced standards and these Specifications, the more stringent shall govern unless directed otherwise by the Engineer. CONTRACTOR shall strictly adhere to OSHA requirements and local codes or those of any regulatory agency or body with jurisdiction
  
- B. This Section includes the following:
  - 1. Sealing for concrete slabs shall be provided in all new buildings including the new electrical building.

1.02 DEFINITIONS

- A. Cementitious Materials: Portland cement (concrete) alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.
  
- B. See Section 03300, “Cast-In-Place Concrete” for curing of slabs prior to application of concrete sealer.

1.03 SUBMITTALS

- A. Submit product data, field quality-control test, and inspection reports in accordance with Section 01300.



#### 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Testing Agency Qualifications: An independent agency, qualified per ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, per ACI CP-01 or an equivalent certification program.
  - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

#### PART 2 - PRODUCTS

##### 2.01 MANUFACTURERS

- A. Basis of Design Product: Curing and Sealing Concrete Floors Interior floor slabs shall be cured and sealed with "CLEAR BOND" by Guardian Chemical Company of Atlanta or BASF MasterKure CC 180 WB" by Sonneborn Building Products of Minneapolis, or equal.
- B. Alternate Basis of Design Product: Subject to compliance with requirements, product that may be incorporated into the Work is Thoroshield by ChemRex, Inc., or equivalent product by an equivalent manufacturer.
- C. The use of other products, suitable for traffic, shall meet the requirements of this Section in regards to a clear, water-based urethane protective coating for use as a sealer for a horizontal concrete substrate with a coefficient of friction as required by 7th Edition Florida Building Code Building (2020). The clear, water-based urethane protective coating installation instructions/requirements on new and fresh concrete shall be coordinated with ACI 318 and section 03300.

#### PART 3 - EXECUTION

##### 3.01 CONCRETE SEALING

- A. Two coats shall be applied in accordance with the manufacture's printed instructions.
- B. New concrete floors shall be cured by applying the first coat as soon as possible after final finishing.
- C. Second coat shall be applied when all other trades are completed and structure is otherwise ready for occupancy.
- D. Surface Prep: Freshly placed concrete must be properly finished. The surface is application ready when it is damp but not wet and when it cannot be marred by foot traffic. Existing concrete surfaces should be thoroughly repaired and cleaned before application. Surface

must be clean, dry and free of dust, oil, grease, sealers and all other surface contaminants that might inhibit proper bond of material.

1. First Coat: BASF MasterKure CC 180 WB 200 – 400 sf/g
  2. Finish Coat: BASF MasterKure CC 180 WB400 – 600 sf/g
- E. Prepare horizontal concrete surface to receive sealer as recommended by sealer manufacturer.
1. All concrete surfaces shall be fully cured
  2. Prepare surface by mechanical means to provide a profile.
  3. Use abrasive shot blasting, sand blasting, or grinding with specialty equipment to prepare surface. Preclean by chemical means before using mechanical means.
- F. Use a continuous operation for each coat, by soft bristle brush or a ¼ inch nap roller per manufacturer's written instructions. Do not spray.
- G. Apply only when surface temperature is above 40 degrees F.
- H. Allow a minimum of 4 hours before applying second coat.

### 3.02 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports. Inspections shall take place whenever sealer is being applied to concrete.
- B. Inspections:
1. Confirm sealing procedures and adherence to manufacturer's recommendations and these specifications.
  2. Verify full coverage of areas to receive concrete sealer.
  3. Inspection results shall be reported in writing to CONTRACTOR within 8 hours of inspection. Reports shall contain Project identification name and number, date of inspection, name of inspector and inspecting agency, results of inspections.
  4. Additional inspecting, at CONTRACTOR's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  5. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 033100

***DIVISION 4***

***MASONRY***

## SECTION 042113 – BRICK VENEER MASONRY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Clay face brick.
  - 2. Mortar and grout.
  - 3. Steel reinforcing bars.
  - 4. Masonry-joint reinforcement.
  - 5. Ties and anchors.
  - 6. Embedded flashing.
  - 7. Miscellaneous masonry accessories.
- B. Products Installed but not Furnished under This Section:
  - 1. Steel lintels in unit masonry.
  - 2. Steel shelf angles for supporting unit masonry.
  - 3. Cavity wall insulation.
- C. Related Requirements:
  - 1. Section 042200 Reinforced Unit Masonry
  - 2. Section 071113 "Bituminous Dampproofing" for dampproofing applied to cavity face of backup wythes of cavity walls.
  - 3. Section 072100 "Thermal Insulation" for cavity wall insulation.
  - 4. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

#### 1.3 ALLOWANCES

- A. Face brick is part of the Face Brick Allowance.

#### 1.4 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.5 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

- C. Samples for Verification: For each type and color of the following:

1. Clay face brick, in the form of straps of five or more bricks.
2. Special brick shapes.
3. Color mortar
4. Weep holes and cavity vents.
5. Accessories embedded in masonry.

- D. Qualification Data: For testing agency.

- E. Material Certificates: For each type and size of the following:

1. Masonry units.
  - a. Include material test reports substantiating compliance with requirements.
  - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
  - c. For exposed brick, include test report for efflorescence according to ASTM C 67.
  - d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing according to ASTM C 67.
  - e. For masonry units, include data and calculations establishing average net-area compressive strength of units.
2. Integral water repellent used in CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

- F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
  2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- G. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- H. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

#### 1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockups for typical exterior and interior walls in sizes approximately 48 inches long by 36 inches high by full thickness, including face and backup wythes and accessories.
    - a. Include a sealant-filled joint at least 16 inches long in exterior wall mockup.
    - b. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
    - c. Include veneer anchors, flashing, cavity drainage material], and weep holes in exterior masonry-veneer wall mockup.
  2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
  3. Clean exposed faces of mockups with masonry cleaner as indicated.
  4. Protect accepted mockups from the elements with weather-resistant membrane.
  5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

#### 1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
  - 2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe, and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
  - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  - 2. Protect sills, ledges, and projections from mortar droppings.
  - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

### 2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
  - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

### 2.3 CONCRETE MASONRY UNITS

- A. See 042200 Reinforced Unit Masonry

### 2.4 CONCRETE AND MASONRY LINTELS

- A. General: Provide one of the following:
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

### 2.5 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:



1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C 216, Grade SW, Type FBX or FBS

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3350 psi.
2. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested according to ASTM C 67.
3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
4. Size (Actual Dimensions): 3-1/2 to 3-5/8" inches wide by 2-1/4 inches high by 7-1/2 to 7-5/8" inches long.
5. Application: Use where brick is exposed unless otherwise indicated.
6. Color and Texture: **ACME Brick MENAWA (Basis of Design)**

## 2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Masonry Cement: ASTM C 91/C 91M.
- D. Mortar Cement: ASTM C 1329/C 1329M.
- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- F. Aggregate for Mortar: ASTM C 144.
1. White-Mortar Aggregates: Natural white sand or crushed white stone.
  2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C 404.
- H. Water: Clean and Potable.

I. Products: Subject to compliance with requirements, provide one of the following:

1. Colored and Non-colored Masonry Cement:
  - a. Magnolia Masonry Cement; Argos
  - b. Rainbow Mortamix Custom Color Masonry Cement; Holnam, Inc.
  - c. Centurion Colorbond; Lafarge Corporation.
  - d. Flamingo Color Masonry Cement; Riverton Corporation (The).
2. Mortar Pigments:
  - a. True Tone Mortar Colors; Davis Colors.
  - b. Centurion Pigments; Lafarge Corporation.
  - c. SGS Mortar Colors; Solomon Grind-Chem Services, Inc.
3. Cold-Weather Admixture:
  - a. Accelguard 80; Euclid Chemical Co.
  - b. Morseled; W. R. Grace & Co., Construction Products Division.
  - c. Trimix-NCA; Sonneborn, Div. of ChemRex, Inc

2.7 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc; #RB or #RB-Twin Rebar Positioner or a comparable product by one of the following:
    - a. Blok-Lok
    - b. Dur-O-Wal; a Hohmann & Barnard company.
    - c. RKL Building Specialties.
- C. Masonry-Joint Reinforcement, General: ASTM A 951/A 951M.
  1. Hot-dip galvanized carbon steel for interior and exterior walls
  2. Wire Size for Side Rods: 0.148-inch diameter.
  3. Wire Size for Cross Rods: 0.148-inch diameter.
  4. Wire Size for Veneer Ties: 0.148-inch diameter.
  5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
  6. Provide in lengths of not less than 10 feet with prefabricated corner and tee units.
- D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc.; 220 Ladder-Mesh Joint Reinforcing or comparable product by one of the following:
  - a. Blok-Lok.
  - b. RKL Building Specialties.
  
- E. Masonry-Joint Reinforcement for Multi-wythe Masonry:
  1. Adjustable (two-piece) type, either ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch (1.5 mm) and maximum vertical adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc.; 270 Ladder LOX\_ALL adjustable eye wire with 2X Pintles or comparable product by one of the following:
      - 1) Blok-Lok.
      - 2) RKL Building Specialties.
  
- F. Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch diameter, hot-dip galvanized carbon steel continuous wire.

## 2.8 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.
  
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
  1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
  2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
  3. Galvanized-Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
  4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
  5. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, [Type 304] [Type 316].
  6. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
  7. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.
  
- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel or stainless-steel wire.

- a. Basis-of-Design Product: subject to compliance with requirements, provide Hohmann & Barnard, Inc.; #359 Weld on Tie or a comparable product by one of the following:
  - 1) Blok-Lok.
  - 2) RKL Building Specialties.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, hot-dip galvanized steel or stainless-steel wire.
  - a. Basis-of-Design Product: subject to compliance with requirements, provide Hohmann & Barnard, Inc.; #301 Column Web Tie or a comparable product by one of the following:
    - 1) Blok-Lok.
    - 2) RKL Building Specialties.
- D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch thick steel sheet, galvanized after fabrication.
  2. Tie Section: Triangular-shaped wire tie made from 0.187-inch diameter, hot-dip galvanized steel wire.
- E. Rigid Anchors: Fabricate from steel bars 1-1/4 inches wide by minimum 12 ga. thick by length as required for the embedded portion notched and corrugated to resist pull out and bent to engage the column when masonry is perpendicular to the flange.
  - a. Basis-of-Design Product: subject to compliance with requirements, provide Hohmann & Barnard, Inc.; #357 Beam Anchor or a comparable product by one of the following:
    - 1) Blok-Lok.
    - 2) RKL Building Specialties.
  2. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M
- F. Adjustable Masonry-Veneer Anchors:
  1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.5 mm).
  2. Fabricate sheet metal anchor sections and other sheet metal parts from [0.075-inch- thick steel sheet, galvanized after fabrication] [0.105-inch-thick steel sheet, galvanized after fabrication]
  3. Fabricate wire ties from [0.187-inch- diameter, hot-dip galvanized-steel wire unless otherwise indicated.

4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Seismic Masonry-Veneer Anchors: Connector section and a sheet metal anchor section, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom; with screw tracks bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch wide by 6 inches long, stamped into center to provide a slot between strap and base for inserting connector section. Self-adhering, modified bituminous gasket fits behind anchor plate and extends beyond pronged legs. Connector section consists of a triangular wire tie and rigid PVC extrusion with snap-in grooves for inserting continuous wire. Fabricate wire connector sections from [0.187-inch-diameter, hot-dip galvanized, carbon-steel wire.
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc.; X-Seal Anchor and Seismiclip or a comparable product by one of the following:
    - 1) Blok-Lok.
    - 2) RKL Building Specialties.

## 2.9 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with Section 076200 "Sheet Metal Flashing and Trim" and as follows:
  1. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304, 0.016 inch thick.
  2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
  3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
  4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
  5. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
  6. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
  7. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
  8. Solder metal items at corners.
- B. Flexible Flashing: Use the following unless otherwise indicated:
  1. Stainless Steel/Polymer Fabric Flashing: ASTM A240/A240M stainless steel bonded with rubber-based adhesive to one sheet of polymer fabric, and manufacturer's standard, self-adhering, stainless steel lap tape. Use only where flashing is fully concealed in masonry.

- a. Basis-of Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc.; Mighty-Flash Flashing or comparable product by one of the following:
- 1) York Manufacturing, Inc.; Multi-Flash SS
  - 2) RKL Building Specialties.
  - 3) Sandell Manufacturing.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge or flexible flashing with a metal drip edge.
4. Where flashing is fully concealed, use flexible flashing.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

E. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

G. Termination Bars for Flexible Flashing: Stainless-steel sheet 0.019 inch by 1 inches with a 3/8 inch sealant flange at top.

H. Stainless Steel Drip Edge Flashing: 26 GA. (304 SS)

## 2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity Vent Products: Use the following unless otherwise indicated:

1. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide Wire-Bond; Cavity Net Weep Vent or comparable product by one of the following:
    - 1) Hohmann & Barnard, Inc.
    - 2) Advanced Building Products
    - 3) CavClear/Archovations, Inc.; Weep Vents
    - 4) Keene Building Products; Driwall Weep Vents
    - 5) Mortar Net Solutions
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity. Installed per manufacturer's recommendations.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Wire-Bond; Cavity Net DT or comparable product by one of the following:
    - a. Advanced Building Products Inc.
    - b. CavClear/Archovations, Inc.
    - c. Heckmann Building Products, Inc.
    - d. Hohmann & Barnard, Inc.
    - e. Mortar Net Solutions.

## 2.11 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Diedrich Technologies, Inc.; a division of Sandell Construction Solutions.
    - b. EaCo Chem, Inc.
    - c. PROSOCO, Inc.

## 2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  1. Do not use calcium chloride in mortar or grout.
- B. Mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For masonry below grade or in contact with earth, use Type S.
  2. For reinforced masonry, use Type S.
  3. For exterior, above-grade, loadbearing, and non-loadbearing walls, use Type S;
  4. For interior load-bearing walls; for interior non-loadbearing partitions; and for other applications where another type is not indicated, use Type N.
- D. Pigmented Mortar: Use colored cement product and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments shall not exceed 10 percent of portland cement by weight.
  2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
  3. Application: Use pigmented mortar for exposed mortar joints with the following units:
    - a. Clay face brick.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
  2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
  3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
  2. Verify that foundations are within tolerances specified.
  3. Verify that reinforcing dowels are properly placed.
  4. Verify that substrates are free of substances that impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.



### 3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

### 3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
  - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
  - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
  - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
  - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
  - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
  - 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
  - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
  - 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

### 3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
  1. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

### 3.5 MORTAR BEDDING AND JOINTING

- A. Lay CMUs as follows:
  1. Bed face shells in mortar and make head joints of depth equal to bed joints.
  2. Bed webs in mortar in all courses of piers, columns, and pilasters.
  3. Bed webs in mortar in grouted masonry, including starting course on footings.
  4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
  5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
  1. For glazed masonry units, use a nonmetallic jointer 3/4 inch or more in width.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

### 3.6 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together as follows:
  1. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
    - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
    - b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement[ with continuous horizontal wire in facing wythe attached to ties].
  2. Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not more than 8 inches clear horizontally and 16 inches clear vertically.
- B. Bond wythes of composite masonry together using bonding system indicated on Drawings.
- C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

- D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
  - 1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
  - 1. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
  - 2. Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

### 3.7 CAVITY WALLS

- A. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Coat cavity face of backup CMU wythe to comply with Division 7 Section "Bituminous Dampproofing"
- D. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
  - 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

### 3.8 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
  - 1. Embed tie sections connector sections and continuous wire in masonry joints.
  - 2. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
  - 3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally, with not less than one anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.
- B. Provide not less than 1 inch of airspace between back of masonry veneer and face of insulation.

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

### 3.9 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
  1. Space reinforcement not more than 16 inches o.c.
  2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

### 3.10 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
  1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### 3.11 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
  1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
  2. Install preformed control-joint gaskets designed to fit standard sash block.
  3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.

4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.

1. , pressure-relieving joints beneath shelf angles supporting masonry.

### 3.12 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### 3.13 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
  1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  2. At multi-wythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
  3. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under water-resistive

- barrier/air barrier], lapping at least 4 inches. Fasten upper edge of flexible flashing to sheathing through termination bar.
4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
  5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
  6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
  7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
  2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
  3. Space weep holes 24 inches o.c. unless otherwise indicated.
  4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
  5. Trim wicking material flush with outside face of wall after mortar has set.
- F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches, to maintain drainage.
- G. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- H. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

### 3.14 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

### 3.15 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
  3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
  4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
  7. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.



3.16 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 042200 - REINFORCED UNIT MASONRY

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes unit masonry assemblies that shall be provided as necessary to construct the new buildings as part of this project. Items included in this section are:
  - 1. Decorative concrete masonry units (Split faced and smooth faced, colored CMU)
  - 2. Mortar and grout
  - 3. Reinforcing steel
  - 4. Masonry joint reinforcement
  - 5. Ties and anchors
  - 6. Miscellaneous masonry accessories
- B. Products furnished, but not installed, under this Section include the following:
  - 1. Anchor sections of adjustable masonry anchors for connecting to structural frame, installed under Division 5 Section "Structural Steel."
- C. Products installed, but not furnished, under this Section include the following:
  - 1. Steel lintels and shelf angles for unit masonry, furnished under Division 5 Section "Metal Fabrications."

1.03 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
  - 1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
- C. Samples for Initial Selection: For the following:
  - 1. Decorative concrete masonry units, in the form of small-scale units.
  - 2. Colored mortar.
  - 3. Weep holes/vents.
- D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
  1. Masonry units.
    - a. Include material test reports substantiating compliance with requirements.
  2. Cementitious materials. Include brand, type, and name of manufacturer.
  3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  4. Grout mixes. Include description of type and proportions of ingredients.
  5. Reinforcing bars.
  6. Joint reinforcement.
  7. Anchors, ties, and metal accessories.
- F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
  1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
  2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- G. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

#### 1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  1. Build mockup of typical wall area as shown on Drawings.

2. Build mockups for typical exterior wall in sizes approximately 48 inches wide and 60 inches high by full thickness, including face and backup wythes and accessories. (Coordinate with Section 07270 – Air & Vapor Barrier.)
    - a. Include a sealant-filled joint at least 16 inches long in each exterior wall mockup.
    - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
    - c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
  3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
  4. Protect accepted mockups from the elements with weather-resistant membrane.
  5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
    - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
    - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
- F. Preinstallation Conference: Conduct conference at Project site to discuss masonry and building construction requirements. Pay special attention to anchoring of door and window frames, providing necessary blocking, and the use of the correct anchor attachments that are provided with all opening frames including but not limited to windows, doors and louvers.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry. Keeping units dry while stored as well as while being laid is very important to the prevention of efflorescence. Make every effort to keep cmu units dry at all times.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

#### 1.07 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work or in the event of rain during a days work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides and anchor cover securely in place. Be advised this aspect of the construction process will be closely monitored.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
  - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  - 2. Protect sills, ledges, and projections from mortar droppings.
  - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
  - 5. Remove any and all stained or damaged blocks that cannot be cleaned.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

## PART 2 – PRODUCTS

### 2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### 2.02 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not uses units where such defects, including dimensions that vary

from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

## 2.03 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide square-edged units for outside corners, unless otherwise indicated.
  - 3. All units to be manufactured with moisture inhibitors.
  
- B. Decorative Concrete Masonry Units: ASTM C 90.
  - 1. Weight Classification: Normal weight.
  - 2. Pattern and Texture:
    - a. Standard pattern, smooth and split face finish, intergrally colored CMU w/ moisture inhibitors. Refer to the Drawings for the block colors.
  - 3. Size (Width): Manufactured to the following dimensions:
    - a. 4 inches nominal; 3-5/8 inches actual.
    - b. 8 inches nominal; 7-5/8 inches actual.
    - c. 12 inches nominal; 11-5/8 inches actual.
  - 4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
    - a. Where units are to be left exposed, provide color and texture matching the range represented by Architect's sample and as indicated on the drawings.
    - b. All units to be manufactured with moisture inhibitors.

## 2.04 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
  
- B. Hydrated Lime: ASTM C 207, Type S.
  
- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
  
- D. Colored Cement Product: Packaged blend made from portland cement and lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
  - 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
    - a. Color for colored, split faced CMU. Refer to the Drawings for the colors.
  - 2. Pigments shall not exceed 10 percent of portland cement by weight.
  - 3. Available Products:
    - a. Colored Portland Cement-Lime Mix:
      - 1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
      - 2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
      - 3) Lafarge North America Inc.; Eaglebond.
      - 4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

- E. Aggregate for Mortar: ASTM C 144.
  - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
- F. Aggregate for Grout: ASTM C 404.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
  - 1. Available Products:
    - a. Addiment Incorporated; Mortar Kick.
    - b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
    - c. Sonneborn, Div. of ChemRex; Trimix-NCA.
- H. Water: Potable.
- I. Mortar shall have moisture inhibitors.
- J. Mortar Joints to be concave struck. Make every effort to produce a dry joint to defeat the passage of water.

## 2.05 REINFORCEMENT

- A. Masonry Joint Reinforcement, General: ASTM A 951.
  - 1. Interior Walls: Hot-dip galvanized, carbon steel.
  - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
  - 3. Wire Size for Side Rods: W1.7 or 0.148-inch diameter.
  - 4. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
  - 5. Wire Size for Veneer Ties: W2.8 or 0.188-inch diameter.
  - 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
  - 7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- B. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

## 2.06 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.
  - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Adjustable Masonry-Veneer Anchors
  - 1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

- a. Wire-Type Anchor: Bent wire anchor section with an eye to receive the wire tie. Wire tie has a vertical leg that slips into the eye of anchor section and allows vertical adjustment. Both sections are made from 3/16-inch, hot-dip galvanized wire.
2. Products:
  - a. Hohmann & Barnard, Inc.: Ladder Style #270 ML.
  - b. Hohmann & Barnard, Inc.: Dovetail slot #305 with #315 and Vee Byna Tic.
3. Space veneer anchors at 1'-4" O.C. vertically and 2'-0" O.C. horizontally unless instructed differently on the structural drawings.

#### 2.07 MISCELLANEOUS ANCHORS

- A. Post installed Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
  1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
  2. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

#### 2.09 MISCELLANEOUS MASONRY ACCESSORIES

- A. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.
  1. Available Products:
    - a. Mortar Net USA, Ltd.; Mortar Net Weep Vents.
  2. Provide weeps at wall bases, opening sills, heads and other obstructions to downward movement of water. Provide thru wall flashing at each weep location. Weeps shall be at 2'-0" O.C. horizontally.

#### 2.10 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
  1. Available Manufacturers:
    - a. Diedrich Technologies, Inc.
    - b. EaCo Chem, Inc.
    - c. ProSoCo, Inc.

### PART 3 – EXECUTION



### 3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
  - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
  - 2. Verify that foundations are within tolerances specified.
  - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. The intent of the drawings is to build to masonry dimensions without cutting. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
  - 1. Mix units from several pallets or cubes as they are placed.
- F. Comply with construction tolerances in TMS 402/602 and with the following:
  - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
  - 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
  - 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
  - 4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
  - 5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

### 3.03 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond and bond pattern indicated on Drawings; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet CMU if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
  1. Install compressible filler in joint between top of partition and underside of structure above.
  2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c., unless otherwise indicated.
  3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 7 Section "Fire-Resistive Joint Systems" as applicable.

### 3.04 MORTAR BEDDING AND JOINTING

- A. Lay concrete masonry units as follows:
  1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
  3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

### 3.05 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
  1. Space reinforcement not more than 16 inches o.c.
  2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
    - a. Reinforcement above is in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

### 3.06 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:

1. Embed tie sections in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.
2. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

### 3.07 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
  1. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick made from clay or shale as follows:
  1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
- D. Install expansion or control joints maximum of 24'-0" O.C.
  2. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants" and indicated on the drawings as "CJ".

### 3.08 LINTELS

- A. Install steel lintels where indicated.
- B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

### 3.09 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
  1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  2. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.

3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
  4. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
  2. Space weep holes 24 inches o.c., unless otherwise indicated.

### 3.10 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 402/602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  2. Limit height of vertical grout pours to not more than 60 inches.

### 3.11 FIELD QUALITY CONTROL

- A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

### 3.12 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

- C. Damp-cure parging for at least 24 hours and protect parging until cured.

### 3.13 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
  - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
  - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
  - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

### 3.14 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
  - 1. Crush masonry waste to less than 4 inches in each dimension.
  - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 2 Section "Earthwork."
  - 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

### 3.15 CONCRETE MASONRY UNIT SCHEDULE

- A. Reference architectural drawings for locations of CMU types and elevations; match exposed face of lintel CMUs with CMU of wall. Color reference is made to colored CMU as manufactured by “Argos.”
- B. Interior walls of CMU shall be standard grey stretcher in widths indicated on floor plans.

END OF SECTION 042300

## SECTION 047200 - CAST STONE MASONRY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Cast-stone trim **including the following:**

- a. Window sills.
    - b. Lintels.
    - c. Surrounds.
    - d. Copings.
    - e. Wall caps.
    - f. Belt courses.
    - g. Water tables.

- B. Related Sections:

- 1. Section 042113 "Brick Veneer Masonry" for installing cast-stone units in unit masonry.
    - 2. Section 042200 "Reinforced Unit Masonry" for installing cast-stone units in unit masonry.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. For cast-stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Shop Drawings: Show fabrication and installation details for cast-stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

- 1. Include building elevations showing layout of units and locations of joints and anchors.

- C. Samples for Initial Selection: For colored mortar.

- D. Samples for Verification:

- 1. For each color and texture of cast stone required, **10 inches (250 mm)** square in size.
    - 2. For each trim shape required, **10 inches (250 mm)** in length.



3. For colored mortar, make Samples using same sand and mortar ingredients to be used on Project.
- E. Full-Size Samples: For each **color texture and shape** of cast-stone unit required.
1. Make available for Architect's review at Project site Approved Samples may be installed in the Work.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
1. Include copies of material test reports for completed projects, indicating compliance of cast stone with ASTM C 1364.
- B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C 1364.
1. Provide test reports based on testing within previous two years.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of cast-stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute.
- B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- C. Mockups: Furnish cast stone for installation in mockups specified in Section 042000 "Unit Masonry."
- D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of typical wall area as shown on Drawings.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.
- B. Pack, handle, and ship cast-stone units in suitable packs or pallets.
1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast-stone units if required, using dollies with wood supports.
  2. Store cast-stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

## 1.7 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602/ACI 530.1/ASCE 6.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602/ACI 530.1/ASCE 6.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Cast Stone: Obtain cast-stone units from single source from single manufacturer.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

### 2.2 CAST-STONE MATERIALS

- A. General: Comply with ASTM C 1364.
- B. Portland Cement: ASTM C 150/C 150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C 114. Provide natural color or white cement as required to produce cast-stone color indicated.
- C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33/C 33M; gradation and colors as needed to produce required cast-stone textures and colors.
- D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33/C 33M, gradation and colors as needed to produce required cast-stone textures and colors.
- E. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, [**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

- F. Admixtures: Use only admixtures specified or approved in writing by Architect.
1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
  2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
  3. Air-Entraining Admixture: ASTM C 260/C 260M
  4. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  5. Water-Reducing, Retarding Admixture: ASTM C 494/C 494M, Type D.
  6. Water-Reducing, Accelerating Admixture: ASTM C 494/C 494M, Type E.
- G. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M, **Grade 60 (Grade 420)**. Use galvanized or epoxy-coated reinforcement when covered with less than **1-1/2 inches (38 mm)** of cast-stone material.
1. Epoxy Coating: ASTM A 775/A 775M.
  2. Galvanized Coating: ASTM A 767/A 767M.
- H. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666, Type 304

## 2.3 CAST-STONE UNITS

- A. Southern Castings, Inc (Basis of Design)
- B. Riley-Stuart Hambrick Cast Stone Services
- C. ACME Brick
- D. Cast-Stone Units: Comply with ASTM C 1364.
1. Units shall be manufactured using the wet-cast method.
  2. Units shall be resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.
- E. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
  2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
  3. Provide drips on projecting elements unless otherwise indicated.
- F. Fabrication Tolerances:
1. Variation in Cross Section: Do not vary from indicated dimensions by more than **1/8 inch (3 mm)**.
  2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater, but in no case by more than **1/4 inch (6 mm)**.

3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch (3 mm), whichever is greater.
4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch (3 mm) on formed surfaces of units and 3/8 inch (10 mm) on unformed surfaces.

G. Cure Units as Follows:

1. Cure units in enclosed, moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F (38 deg C) for 12 hours or 70 deg F (21 deg C) for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:
  - a. No fewer than five days at mean daily temperature of 70 deg F (21 deg C) or above.
  - b. No fewer than six days at mean daily temperature of 60 deg F (16 deg C) or above.
  - c. No fewer than seven days at mean daily temperature of 50 deg F (10 deg C) or above.
  - d. No fewer than eight days at mean daily temperature of 45 deg F (7 deg C) or above.

H. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

I. Colors and Textures: Basis of Design - Southern Castings, Inc - Gray, (As selected by Architect from manufacturer's full range).

J. Colors and Textures: Provide units with fine-grained texture and buff color resembling sand-rubbed Indiana limestone.

K. Colors and Textures: Provide units with fine texture and red-brown color resembling brownstone on adjacent buildings.

## 2.4 MORTAR MATERIALS

- A. Provide mortar materials that comply with Section 042113 "Brick Veneer Masonry."
- B. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Masonry Cement: ASTM C 91/C 91M.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- G. White-Mortar Aggregates: Natural white sand or crushed white stone.

- H. es: Natural white sand or crushed white stone.
- I. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- J. Colored Cement Product: Packaged blend made from portland cement and hydrated lime masonry cement or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
  - 1. Colored Portland Cement-Lime Mix:
  - 2. Colored Masonry Cement:
    - a. Magnolia Masonry Cement; Argos
    - b. Rainbow Mortamix Custom Color Masonry Cement; Holnam, Inc.
    - c. Centurion Colorbond; Lafarge Corporation.
    - d. Flamingo Color Masonry Cement; Riverton Corporation (The).
  - 3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
  - 4. Pigments shall not exceed 10 percent of portland cement by weight.
  - 5. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
- K. Aggregate for Mortar: ASTM C 144.
  - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
  - 2. For joints less than **1/4 inch (6 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
  - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
  - 4. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- L. Water: Potable.

## 2.5 ACCESSORIES

- A. Anchors: Type and size indicated, fabricated from steel complying with ASTM A 36/A 36M and hot-dip galvanized to comply with ASTM A 123/A 123M.
- B. Dowels: **1/2-inch- (12-mm-)** diameter round bars, fabricated from steel complying with ASTM A 36/A 36M and hot-dip galvanized to comply with ASTM A 123/A 123M.
- C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast-stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Diedrich Technologies, Inc.; a division of Sandell Construction Solutions.
  - b. EaCo Chem, Inc.
  - c. PROSOCO, Inc.

## 2.6 MORTAR MIXES

- A. Comply with requirements in Section 042000 "Unit Masonry" for mortar mixes.
- B. Do not use admixtures including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  1. Do not use calcium chloride in mortar or grout.
  2. Use portland cement-lime, masonry cement, or mortar cement mortar unless otherwise indicated.
- C. Comply with ASTM C 270, Proportion Specification..
  1. For setting mortar, use Type N.
  2. For pointing mortar, use Type N
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
  1. Pigments shall not exceed 10 percent of portland cement by weight.
  2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
  3. Mix to match Architect's sample.
  4. Application: Use pigmented mortar for exposed mortar joints.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
  1. Mix to match Architect's sample.
  2. Application: Use colored-aggregate mortar for exposed mortar joints.

## 2.7 SOURCE QUALITY CONTROL

- A. Engage a qualified independent testing agency to sample and test cast-stone units according to ASTM C 1364.
  1. Include one test for resistance to freezing and thawing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 SETTING CAST STONE IN MORTAR

- A. Install cast-stone units to comply with requirements in Section 042000 "Unit Masonry."
- B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
  - 1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
  - 2. Coordinate installation of cast stone with installation of flashing specified in other Sections.
- C. Wet joint surfaces thoroughly before applying mortar or setting in mortar.
- D. Set units in full bed of mortar with full head joints unless otherwise indicated.
  - 1. Set units with joints **1/4 to 3/8 inch (6 to 10 mm)** wide unless otherwise indicated.
  - 2. Build anchors and ties into mortar joints as units are set.
  - 3. Fill dowel holes and anchor slots with mortar.
  - 4. Build concealed flashing into mortar joints as units are set.
  - 5. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
  - 6. Keep joints at shelf angles open to receive sealant.
- E. Rake out joints for pointing with mortar to depths of not less than **3/4 inch (19 mm)**. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.
- F. Point mortar joints by placing and compacting mortar in layers not greater than **3/8 inch (10 mm)**. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
- G. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.
- H. Rake out joints for pointing with sealant to depths of not less than **3/4 inch (19 mm)**. Scrub faces of units to remove excess mortar as joints are raked.
- I. Point joints with sealant to comply with applicable requirements in Section 079200 "Joint Sealants."

1. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
- J. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.
1. Keep joints free of mortar and other rigid materials.
  2. Build in compressible foam-plastic joint fillers where indicated.
  3. Form joint of width indicated, but not less than **3/8 inch (10 mm)**
  4. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
  5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

### 3.3 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

- A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
  2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.
- B. Keep cavities open where unfilled space is indicated between back of cast-stone units and backup wall; do not fill cavities with mortar or grout.
- C. Fill anchor holes with sealant.
1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.
- D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.
- E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast-stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.
1. Form open joint of width indicated, but not less than **3/8 inch (10 mm)**.
- F. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
- G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."



### 3.4 INSTALLATION TOLERANCES

- A. Variation from Plumb: Do not exceed **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **1/2 inch (12 mm)** maximum.
- B. Variation from Level: Do not exceed **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **1/2 inch (12 mm)** maximum.
- C. Variation in Joint Width: Do not vary joint thickness more than **1/8 inch in 36 inches (3 mm in 900 mm)** or one-fourth of nominal joint width, whichever is less.
- D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than **1/16 inch (1.5 mm)**, except where variation is due to warpage of units within tolerances specified.

### 3.5 ADJUSTING AND CLEANING

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.
- B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean cast stone as work progresses.
  - 1. Remove mortar fins and smears before tooling joints.
  - 2. Remove excess sealant immediately, including spills, smears, and spatter.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
  - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  - 2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
  - 3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
  - 4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
  - 5. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  - 6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 047200

***DIVISION 5***

***METALS***

051200– STRUCTURAL STEEL

PART 1- GENERAL

1.01 SUMMARY

A. Description of scope and intent:

1. CONTRACTOR shall provide all material, labor, and tools required to complete the installation of specified system.
2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the CONTRACTOR of the obligation to provide same.
3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
4. Installation shall be accomplished by workers skilled in their craft who will perform their work in a professional manner and will leave the premises safe, orderly, and clean.
5. Drawings and general provisions of Contract, including General and Supplemental Conditions and Division 1 Specification Sections, apply to this Section.
6. CONTRACTOR is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees, and services necessary for completion of work in this Section.
7. In the event of a conflict between the Design Drawings, referenced standards and these Specifications, the more stringent shall govern unless directed otherwise by the ENGINEER. CONTRACTOR shall strictly adhere to OSHA requirements and local codes or those of any regulatory agency or body with jurisdiction.

B. Section Includes:

1. Fabrication and erection of structural steel framing members, as defined in AISC Code and as indicated on the drawings.
2. Fabrication and erection of architecturally exposed structural steel (AESS).
3. Welding.
4. Shop painting.

C. Products Furnished but not installed under this section:

1. Steel anchorages cast in concrete.
2. Steel anchorages embedded in masonry.

1.02 REFERENCES

Comply with the following documents, except where requirements of the Contract Documents or of governing codes and governing authorities are more stringent. All referenced standards refer to the edition in force at the time these plans and specifications are issued.

- A. ASTM A 36 -- Standard Specification for Structural Steel
- B. ASTM A 6 -- General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use
- C. ASTM A 123 -- Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

- D. ASTM A 307 -- Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
- E. ASTM A 325 -- Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- F. ASTM A 500 -- Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- G. ASTM A 786 -- Rolled Steel Floor Plates
- H. ASTM A 992 -- Specification for Structural Steel Shapes
- I. ASTM C 1107 -- Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- J. ASTM E 94 -- Standard Guide for Radiographic Testing
- K. ASTM E 142 -- Standard Method for Controlling Quality of Radiographic Testing
- L. ASTM E 164 -- Standard Practice for Ultrasonic Contact Examination of Weldments
- M. ASTM E 165 -- Standard Test Method for Liquid Penetrant Examination
- N. ASTM E 709 -- Standard Guide for Magnetic Particle Examination
- O. ASTM F 959 -- Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
- P. AWS D1.1 -- Structural Welding Code - Steel; American Welding Society
- Q. Code of Standard Practice for Steel Buildings and Bridges; American Institute of Steel Construction, Inc. (AISC)
- R. Specification for Structural Steel Buildings -- Allowable Stress Design and Plastic Design; American Institute of Steel Construction, Inc. (AISC)
- S. Specification for Structural Joints Using ASTM A325 or A490 Bolts; Research Council on Structural Connections; American Institute of Steel Construction, Inc. (AISC)
- T. Steel Structures Painting Manual, Volume 2, Systems and Specifications; Steel Structures Painting Council (SSPC)

### 1.03 DEFINITIONS

- A. Structural Steel: Items as listed in 2.1 of AISC "Code of Standard Practice for Steel Buildings and Bridges," and excluding steel, iron, or other metal items not listed, even if attached to the structural framing.

#### 1.04 SYSTEM DESCRIPTION

- A. General: Unless otherwise specifically approved in writing, furnish exact sections, weights, and kinds of material specified, using details and dimensions shown.
  - 1. Not all connections are detailed; similar details apply to similar conditions, unless otherwise indicated. Contact the Architect promptly to verify design of members or connections in any situation where design requirements are unclear.

#### 1.05 SUBMITTALS

- A. Product Data: Producer's or manufacturer's information for products as follows, including sufficient data to show compliance with specified requirements:
  - 1. Mill test reports for each type of structural steel furnished.
  - 2. Test reports for high-strength bolts, nuts, and washers, including chemical analysis, tensile strength tests, and hardness tests.
  - 3. Test reports for direct tension indicators.
  - 4. Specifications for primer paint, including manufacturer's data on chemical composition, adhesion of spray fireproofing, and dry film thickness per applied coat.
  - 5. Specifications for non-shrink grout.
- B. Shop Drawings: Complete drawings for structural steel, including information on location, type, and size of all connections, distinguishing between those made in the shop and those made in the field.
  - 1. Indicate weld lengths and sizes, using standard American Welding Society (AWS) welding symbols.
  - 2. Include setting drawings and templates for anchorages to be installed by others.
  - 3. Prepare shop drawings under the seal of a professional structural ENGINEER registered in the state of Florida.
  - 4. The fabricator is specifically responsible for the adequacy of any connections designed by the fabricator to performance standards established in the contract documents. Approval by the ENGINEER of shop drawings shall not relieve the fabricator of this responsibility, despite wording to the contrary in paragraph 4.2.1 of the AISC Code.
- C. Test Reports: Submit test reports for all specified tests of connections.
- D. Welder Qualifications: Evidence that welders employed in the work are currently certified under American Welding Society (AWS) qualification procedures.
- E. Surveys: Certified copies of specified surveys, showing locations of all critical elements and deviations from data shown on contract documents.

#### 1.06 QUALITY ASSURANCE

- A. Welding Procedures: Establish that joint welding procedures are prequalified or test in accordance with American Welding Society (AWS) qualification procedures.
- B. Regulatory Requirements: Unless other requirements of governing authorities or particular requirements of this specification are more stringent, comply with provisions of the following:
  - 1. AISC "Code of Standard Practice for Steel Buildings and Bridges."

2. AISC "Specification for Structural Steel Buildings -- Allowable Stress Design and Plastic Design," with Commentary and Supplements.
  3. AWS D1.1, "Structural Welding Code - Steel."
- C. Testing and Inspection Agency: Engage an independent testing and inspection agency acceptable to the OWNER to perform testing, inspect and evaluate connections, and prepare test reports.
1. Correct deficiencies in the structural steel work identified by the testing and inspection agency at no additional expense to the OWNER. Subsequent tests to confirm the adequacy of corrected work will be at the CONTRACTOR's expense.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Shipping: Deliver steel in timely fashion, to permit the most efficient and economical flow of work. Deliver steel members properly marked for field assembly and erection.
1. Deliver anchor bolts, washers, and other anchorage devices to be built into other work in time to avoid delays and permit their proper installation.
- B. Storage: Protect steel and other materials of this section from damage and corrosion. If temporary storage at the project site is required, keep steel members off the ground, using platforms or pallets, in location easily accessible for inspection.

### PART 2- PRODUCTS

#### 2.01 STEEL MATERIALS

- A. AESS Materials - General: For members which will be exposed in the finished work and have been identified as AESS on the drawings, provide only materials which are free of surface blemishes such as pitting, roller marks, rolled trade names, and surface roughness.
- B. Structural Steel Members (refer to plans for locations indicated):
1. Wide flanges and WT sections: ASTM A992, Fy=50 ksi
  2. Channels, angles, plates, and miscellaneous steel: ASTM A36, Fy=36 ksi
  3. 316 Stainless Steel: ASTM A484, ASTM A276, Fy=30 ksi
  4. Structural Tubing, Cold-Formed: ASTM A500, Fy=46 ksi
  5. Steel Pipe: ASTM A53, Type E or S, Grade B, Fy=35 ksi
- C. Anchor Bolts: ASTM F1554, Carbon steel, Grade 36; ASTM A 36 steel plate washers.
- D. Bolts and Nuts:
1. Carbon Steel: ASTM A307, Grade A
  2. High Strength Steel: ASTM A325, Type 1, plain (medium carbon steel)
  3. Stainless Steel: ASTM F593, ASTM F594
  4. AESS: Provide hexagonal bolt heads and nuts at all exposed connections.
- E. Hardened Washers: ASTM F436, ASTM A240 (for stainless)
1. Dimensional requirements shall meet ANSI B18.22.1, Type A plain.
- F. Direct Tension Indicators: At CONTRACTOR's option, provide either load indicator washers complying with ASTM F 959 or snap-off high-strength bolts certified to provide the minimum fastener tension in accordance with AISC "Specification for Structural Joints Using ASTM

A325 or A490 Bolts" at all connections requiring high-strength bolts.

- G. Shear Connectors: ASTM A108, Grades 1010 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B. Minimum Yield Strength = 50 ksi. Test Shear connectors in accordance with AWS. All studs shall be a minimum  $\frac{3}{4}$ " diameter unless otherwise noted.

## 2.02 MISCELLANEOUS MATERIALS

- A. Welding Electrodes and Fluxes: AWS D1.1, Types as follows:
1. E70XX.
- B. Nonshrink Grout: Prepackaged material requiring only the addition of water and complying with ASTM C 1107, and as follows:
1. Natural aggregate (nonmetallic) type.
  2. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable:
    - a. "Masterflow 928"; Master Builders, Inc.
    - b. "SonogROUT 14k"; Sonneborn Building Products Division/ChemRex, Inc.
    - c. "Euco N-S Grout"; The Euclid Chemical Company.
    - d. "Supreme"; Cormix Construction Chemicals.
    - e. "Five Star Grout"; Five Star Products, Inc.
- C. Shop Primer: Fabricator's standard primer.

## 2.03 FABRICATION

- A. Shop Assembly - General: Comply with requirements of AISC Specifications. Shop fabricate and assemble to maximum degree possible.
1. AESS: Comply with requirements of AISC Code for architecturally exposed structural steel.
    - a. Appearance: Cut, fit, and assemble units with exposed surfaces smooth, square, and free from cutting marks, shear distortion, burrs, and nicks.
    - b. Tolerances: As specified in AISC Code for AESS, unless more stringent requirements are indicated on the drawings.
- B. Thermal Cutting: Perform all thermal cutting by machine.
1. Plane thermally cut edges which are to be welded.
- C. Connections:
1. Shop connections: As indicated on the drawings.
  2. Field connections: As indicated on the drawings.
  3. Bolts: High-strength steel bolts, except as otherwise indicated.
    - a. Bolting: Comply with requirements of AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
  4. Welds: Comply with requirements of AWS Code for welding procedures and quality of welds, including appearance.
    - a. Built-up sections: Assemble components and weld using procedures which will maintain proper alignment of finished section.
    - b. AESS: Verify that weld sizes, fabrication sequence, and equipment to be employed will limit distortions to allowable tolerances. Surface bleed of back-side welding on exposed surfaces will not be acceptable.

- 1) Grind smooth exposed fillet welds 1/2 inch and larger.
- 2) Grind flush butt welds.
- 3) Dress all exposed welds.

- D. Finishing: Accurately mill ends of columns and other members which must transmit loads in bearing.
- E. Holes in Steel Members: Make all holes by means of cutting, drilling, or punching at right angles to surface of metal. Do not make or enlarge holes by burning.
1. Provide holes in steel members as required to permit connection of work by others.

#### 2.04 SHOP COATING – GALVANIZING

- A. Galvanize the following items:
1. All structural steel exposed to weather and as indicated on drawings.
- B. Preparation: Thoroughly clean members to be galvanized, removing loose rust and mill scale.
- C. Galvanizing: Perform galvanizing after fabrication in accordance with requirements of ASTM A 123, except galvanize all fastener assemblies in accordance with ASTM A153, use galvanizing methods which provide surface suitable for painting with min class A slip coefficient (0.33).

#### 2.05 SHOP COATING – PAINT

- A. Shop prime all steel members, except:
1. Galvanized steel members.
  2. Steel members embedded in concrete or mortar.
  3. Do not paint the following surfaces:
    - a. Machined or milled surfaces.
    - b. Surfaces adjacent to field welds.
    - c. Faying surfaces of bolted connections.
    - d. Portions of member that receive a special coating. Refer to Section 09900.
- B. Preparation: Thoroughly clean steel surfaces to be shop primed, removing loose rust, loose mill scale, dirt, oil, and grease. Clean steel in accordance with SSPC procedures as follows:
1. Power tool or blast cleaning: SSPC SP-3, -5, -6, or -10.
- C. Painting: As soon as possible after cleaning, apply specified primer paint in accordance with instructions of paint manufacturer, at a rate sufficient to provide a finished thickness of not less than 1.5 mils and an average thickness of 2.0 mils.

#### 2.06 SHOP QUALITY CONTROL

- A. Testing and Inspection:
1. General: Provide access to testing and inspection agency so that specified testing and inspection can be safely accomplished.
  2. Shop bolted connections: Comply with testing and verification procedures in AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts," except test not less than the following number of bolts in each bolted connection: All slip critical connections as noted SC on drawings.



3. Shop welded connections: Inspect and test shop-fabricated welds as follows:
  - a. Visually inspect all welds.
  - b. Inspect 100. percent of full penetration welds, using test method as follows:
    - 1) Radiographic testing (ASTM E 94 and ASTM E 142).
  - c. Inspect 20 percent of fillet welds, using one of the following test methods:
    - 1) Radiographic Testing (ASTM E 94 and ASTM E 142).
    - 2) Magnetic Particle Inspection (ASTM E 709).
    - 3) Ultrasonic Testing (ASTM E 164).
    - 4) Liquid Penetrant Inspection (ASTM E 165).

## PART 3- EXECUTION

### 3.01 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions for erection of structural steel and verify that the work may properly proceed. Do not commence erection of structural steel until unsatisfactory conditions have been corrected or fabricated steel components have been adjusted with the architect's agreement.
  1. Surveys: Conduct verification surveys by a professional ENGINEER or land surveyor registered in the state of Florida.

### 3.02 PREPARATION

- A. Temporary Support: Provide temporary guys, braces, falsework, cribbing, or other elements required to secure the steel framing against loads equal in intensity to design loads. Remove such temporary support only when permanent connections have been made and the steel framing is fully capable of supporting design loads, including any temporary construction loads.

### 3.03 ERECTION

- A. General: Erect structural steel in compliance with AISC Code of Standard Practice and Specifications.
  1. AESS: Comply with erection requirements of AISC Code dealing with architecturally exposed structural steel.
- B. Assembly:
  1. Set structural members accurately to locations and elevations indicated, within tolerances established in AISC Code, before making final connections.
  2. Do not use thermal cutting to correct fabrication errors on any major structural member.
    - a. Thermal cutting of secondary members may be permitted by the architect upon request, but only when members involved are not loaded.
- C. Columns and Bearing Surfaces:
  1. Clean bearing and contact surfaces before assembly. Slightly roughen concrete and masonry surfaces to improve bond.
  2. Set base and bearing plates accurately, using metal wedges, shims, or setting nuts as required.
  3. After tightening anchor bolts and ensuring that structure is plumb, grout solidly between plates and bearing surfaces.
    - a. Comply with manufacturer's instructions for nonshrink grout.

- D. Bolting:
1. Carbon steel bolts: Use only for temporary bracing during erection, unless otherwise specifically permitted by contract documents.
  2. High-strength bolts: Comply with requirements of AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- E. Welding:
1. Do not perform field welding when ambient temperature is at 0 degrees F or below, or when surfaces are wet, exposed to rain, snow, or high wind.
  2. Perform field welding in accordance with AWS "Structural Welding Code - Steel."
  3. Tighten and leave in place erection bolts used in field-welded construction.
    - a. AESS: Verify that weld sizes, erection sequence, and equipment to be employed will limit distortions to allowable tolerances. Surface bleed of back-side welding on exposed surfaces is not acceptable.
      - 1) Grind smooth exposed fillet welds 1/2 inch and larger.
      - 2) Grind flush butt welds.
      - 3) Dress all exposed welds.
      - 4) Remove erection bolts, plug-weld bolt holes, and grind smooth.
- F. Touch-up Painting: As soon as possible after erection of primed structural steel, clean painted areas which have been abraded or otherwise damaged by welding, bolting, or other field operations. Apply touch-up paint matching shop coating by brush or spray to all damaged paint areas, achieving a minimum final thickness of 1.5 mils.

### 3.04 FIELD QUALITY CONTROL

- A. Testing and Inspection:
1. General: Provide access to testing and inspection agency so that specified testing and inspection can be safely accomplished.
  2. Field-bolted connections: Comply with testing and verification procedures in AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts," except test not less than the following number of bolts in each bolted connection: All slip critical connections as noted SC on the drawings.
  3. Field-welded connections: Inspect and test field-fabricated welds as follows:
    - a. Visually inspect all field welds.

END OF SECTION 051200

## SECTION 051213 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Architecturally exposed structural steel (AESS).
- 2. Section 051200 "Structural Steel Framing" requirements that also apply to AESS.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other metal items not defined as structural steel.

#### 1.3 DEFINITIONS

- A. AESS: Architecturally exposed structural steel.
- B. Category AESS 1: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 1 and may be designated AESS 1 or Category AESS 1 in the Contract Documents.
- C. Category AESS 2: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 2 and is designated as AESS 2 or Category AESS 2 in the Contract Documents.
- D. Category AESS 3: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 3 and is designated as AESS 3 or Category AESS 3 in the Contract Documents.
- E. SEAC/RMSCA Guide Specification: SEAC/RMSCA's "Sample Specification, Section 050213: Architecturally Exposed Structural Steel."

#### 1.4 COORDINATION

- A. Coordinate surface preparation requirements for shop-primed items.

- B. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

#### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at job site trailer.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Fabricator.
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

#### 1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172) and is experienced in fabricating AESS similar to that indicated on this Project.
- B. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P3 or SSPC-QP 3.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Use special care in handling AESS to prevent twisting, warping, nicking, and other damage during fabrication, delivery, and erection. Store materials to permit easy access for inspection and identification. Keep AESS members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect AESS members and packaged materials from corrosion and deterioration.
  - 1. Do not store AESS materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

#### 1.9 FIELD CONDITIONS

- A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

### PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of ANSI/AISC 303, Sections 1 through 9 and as modified in Section 10, "Architecturally Exposed Structural Steel."

## 2.2 FILLER

- A. Polyester filler intended for use in repairing dents in automobile bodies.

## 2.3 FABRICATION

- A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
  - 1. Use special care handling and fabricating AESS before and after shop painting to minimize damage to shop finish.
- B. Category AESS 1:
  - 1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
  - 2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
  - 3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
  - 4. Make intermittent welds appear continuous, using filler or additional welding.
  - 5. Seal weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates.
  - 6. Limit butt and plug weld projections to 1/16 inch (1.6 mm).
  - 7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
  - 8. Remove weld spatter, slivers, and similar surface discontinuities.
  - 9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
  - 10. Grind tack welds smooth unless incorporated into final welds.
  - 11. Remove backing and runoff tabs, and grind welds smooth.
- C. Category AESS 2:
  - 1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
  - 2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
  - 3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
  - 4. Make intermittent welds appear continuous, using filler or additional welding.

5. Seal weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates.
6. Limit butt and plug weld projections to 1/16 inch (1.6 mm).
7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
8. Remove weld spatter, slivers, and similar surface discontinuities.
9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
10. Grind tack welds smooth unless incorporated into final welds.
11. Remove backing and runoff tabs, and grind welds smooth.
12. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
13. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. Conceal fabrication and erection markings from view in the completed structure.
16. Make welds uniform and smooth.

D. Category AESS 3:

1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
4. Make intermittent welds appear continuous, using filler or additional welding.
5. Seal weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates.
6. Limit butt and plug weld projections to 1/16 inch (1.6 mm).
7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
8. Remove weld spatter, slivers, and similar surface discontinuities.
9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
10. Grind tack welds smooth unless incorporated into final welds.
11. Remove backing and runoff tabs, and grind welds smooth.
12. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
13. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. Conceal fabrication and erection markings from view in the completed structure.
16. Make welds uniform and smooth.
17. Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.

18. Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
19. Orient HSS seams as indicated or away from view.
20. Align and match abutting member cross sections.
21. At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of 1/8 inch (3.2 mm). At closed joints, maintain uniform contact within 1/16 inch (1.6 mm).
22. Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.

E. Category AESS 4:

1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
4. Make intermittent welds appear continuous, using filler or additional welding.
5. Seal weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates.
6. Limit butt and plug weld projections to 1/16 inch (1.6 mm).
7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
8. Remove weld spatter, slivers, and similar surface discontinuities.
9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
10. Grind tack welds smooth unless incorporated into final welds.
11. Remove backing and runoff tabs, and grind welds smooth.
12. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
13. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. Conceal fabrication and erection markings from view in the completed structure.
16. Make welds uniform and smooth.
17. Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.
18. Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
19. Orient HSS seams as indicated or away from view.
20. Align and match abutting member cross sections.
21. At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of 1/8 inch (3.2 mm). At closed joints, maintain uniform contact within 1/16 inch (1.6 mm).
22. Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.
23. Treat HSS seams to appear seamless.
24. Contour and blend welds and weld transitions between members, removing splatter exposed to view.

25. Fill surface imperfections with filler and sand smooth to achieve surface quality approved by Architect.
26. Minimize weld show-through and distortion on the opposite side of exposed connections by grinding to a smooth profile aligned with adjacent material.

- F. Erection marks, painted marks, and other marks are not permitted.
- G. Cleaning Corrosion-Resisting (Weathering) AESS: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6 (WAB)/NACE WAB-3.

## 2.4 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
  2. Surfaces to be field welded.
  3. Surfaces to be high-strength bolted with slip-critical connections.
  4. Corrosion-resisting (weathering) steel surfaces.
  5. Galvanized surfaces.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments, showing dimensions, locations, angles, and elevations.
- B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

### 3.3 ERECTION

- A. Take special care during erection to avoid marking or distorting the AESS and to minimize



damage to shop painting. Set AESS accurately in locations and to elevations indicated and according to ANSI/AISC 303 and ANSI/AISC 360.

1. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Take care to avoid any blemishes, holes, or unsightly surfaces resulting from the use or removal of temporary elements.
  2. Grind tack welds smooth.
  3. Remove backing and runoff tabs, and grind welds smooth.
  4. Orient bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
  5. Remove erection bolts in Category AESS 4, fill holes with weld metal or filler, and grind or sand smooth to achieve surface quality approved by Architect.
  6. Fill weld access holes in Category AESS 4 with weld metal or filler and grind, or sand smooth to achieve surface quality as approved by Architect.
  7. Conceal fabrication and erection markings from view in the completed structure.
- B. In addition to ANSI/AISC 303, Section 10 requirements, comply with the following.
1. Erection of Category AESS 1 and Category AESS 2:
    - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
    - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
    - c. Remove weld spatter, slivers, and similar surface discontinuities.
    - d. Grind off butt and plug weld projections larger than 1/16 inch (1.6 mm).
    - e. Continuous welds shall be of uniform size and profile.
    - f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
    - g. Splice members only where indicated on Drawings.
    - h. No torch cutting or field fabrication is permitted.
  2. Erection of Category AESS 3:
    - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
    - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
    - c. Remove weld spatter, slivers, and similar surface discontinuities.
    - d. Grind off butt and plug weld projections larger than 1/16 inch (1.6 mm).
    - e. Continuous welds shall be of uniform size and profile.
    - f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
    - g. Splice members only where indicated on Drawings.
    - h. No torch cutting or field fabrication is permitted.
    - i. Weld profiles, quality, and finish shall be as approved by Architect.
    - j. Make joint welds, including tack welds, appear continuous by filling intermittent

welds.

### 3.4 REPAIR

#### A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting, to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting.", Section 099123 "Interior Painting." and Section 099600 "High-Performance Coatings."

#### B. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051213

052100 – STEEL JOISTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Description of scope and intent:
  - 1. Contractor to provide all material, labor, and tools required to complete the installation of specified system.
  - 2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the contractor of the obligation to provide same.
  - 3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  - 4. Installation shall be accomplished by workers skilled in their craft who will perform their work in a professional manner and will leave the premises safe, orderly and clean.
  - 5. Drawings and general provisions of Contract, including General and Supplemental Conditions and Division 1 Specification Sections, apply to this Section.
  - 6. Contractor is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees and services necessary for completion of work in this Section.
  - 7. In the event of a conflict between the Design Drawings, referenced standards and these Specifications, the more stringent shall govern unless directed otherwise by the Engineer. Contractor shall strictly adhere to OSHA requirements and local codes or those of any regulatory agency or body with jurisdiction.
  
- B. Section Includes:
  - 1. K-series open web steel joists.
  - 2. LH-series open web steel joists
  - 3. Bracing.
  
- C. Products Furnished but Not Installed under This Section:
  - 1. Bearing plates.
  - 2. Anchor bolts.
  
- D. Related Sections:
  - 1. Structural steel: Elsewhere in Division 5.
  - 2. Metal decking: Elsewhere in Division 5.

1.02 REFERENCES

- A. AWS D1.1-92 -- Structural Welding Code--Steel; American Welding Society; 1992.
  
- B. SJI Technical Digest No. 9 -- Handling and Erection of Steel Joists and Joist Girders; Steel Joist Institute; July 1987.
  
- C. Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders; Steel Joist Institute (SJI); 1992.

### 1.03 SYSTEM DESCRIPTION

- A. Provide joist system which is designed and fabricated to comply with requirements of the contract documents and which strictly conforms to material, manufacturing, and erection requirements of the Steel Joist Institute's (SJI) "Standard Specifications Load Tables and

Weight Tables for Steel Joists and Joist Girders" (referred to hereinafter as SJI "Specifications").

1. Wind Uplift and Shear: Design joists, joist to joist connections, and joist to structure connections to comply with wind criteria requirements indicated in the structural drawings

### 1.04 SUBMITTALS

- A. Product Data: Submit for each distinct type of joist required and for accessories.
- B. Shop Drawings: Drawings for fabrication and erection of joists; include plans, elevations, and large scale details of typical sections, special connections, joining, and accessories.
1. Show location and spacing of joists; indicate mark number and type.
  2. Prepare shop drawings under the seal of a professional structural engineer registered in the state of Florida.
  3. Show bridging.
  4. Provide design calculations prepared by a professional structural engineer registered in the state of Florida.
- C. Quality Control Submittals: Submit the following:
1. SJI certification of joist characteristics.
  2. Manufacturers' certification of joist characteristics.
  3. Manufacturer's installation instructions, including specific installation sequence.

### 1.05 QUALITY ASSURANCE

- A. Field Welder Qualification: Qualify welding procedures and each welder in accordance with the American Welding Society's "Structural Welding Code -- Steel (AWS D1.1)."
- B. Testing: Engage an independent testing agency acceptable to the owner to perform specified quality control procedures and to prepare reports.
1. Only AWS-certified welding inspectors shall inspect and evaluate welds.

### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Strictly conform to requirements of SJI Technical Digest No. 9.

### 1.07 COORDINATION

- A. Coordination Data: Prepare and distribute to affected installers, drawings or templates detailing placement of bearing plates and anchor bolts.

## PART 2- PRODUCTS

## 2.01 MATERIALS

- A. Steel: Conform to requirements of SJI "Specifications."
- B. Steel Primer for K-Series and LH-Series Joists: Conform to requirements of SJI "Specifications."
- C. Accessories: Provide accessories required for erection of steel joists, complying with SJI "Specifications" and with contract documents.

## 2.02 JOIST FABRICATION

- A. General: All materials shall be clean and straight.
- B. Bridging is schematically shown on drawings. Detail and fabricate bridging in complete accordance with SJI requirements.
- C. Joists:
  - 1. Top chord extensions: Provide extensions where indicated. Extension members shall be designed as cantilever beams, with their reactions carried back at least to the first panel point of the joists.
  - 2. Bottom chords: Form bottom chord members of joists using angles.
  - 3. Bottom chord extensions: Where indicated, provide extended bottom chords or separate extension units properly designed to support ceilings attached directly to joist bottom chords. Maximum clearance between wall finish and end of extension: 1/2 inch, unless indicated otherwise.
  - 4. Special end connections: Provide special end connections where joists bear less than 2-1/2 inches over steel supports. Connections shall provide positive attachment to the support.
  - 5. Camber: Comply with recommendations of SJI "Specifications."
  - 6. Surface preparation for shop priming: Hand clean steel in accordance with SSPC-Paint 15 requirements.
  - 7. Shop priming: Provide 1-mil continuous dry paint film thickness.
  - 8. Bearing plates: Furnish bearing plates fabricated from same grade of steel as joists, with welded stud anchors or anchor bolts, or as otherwise shown on drawings.

## 2.03 SHOP QUALITY CONTROL

- A. Inspection:
  - 1. Provide access to independent testing and inspection agency so that inspection can be accomplished safely.
  - 2. Independent testing and inspection agency shall visually inspect shop welds to verify compliance with the American Welding Society's "Structural Welding Code -- Steel (AWS D1.1)."

## PART 3- EXECUTION

### 3.01 ERECTION

- A. Do not begin joist erection until structural support components have been installed and are in suitable condition to receive joists.
- B. Do not overload or exceed carrying capacity of any joist during construction period.
- C. Accurately position and space joists before permanent attachment to structural supports.
- D. Provide safe, stable structure throughout construction period. Do not remove bridging after construction is completed, unless specifically authorized to do so by the Engineer.
  - 1. Install bridging in accordance with SJI requirements.
  - 2. Bridging installation shall proceed concurrently with joist erection and shall be completed before joists are subjected to construction loads.
- E. K-Series and LH Series Joist Anchorage:
  - 1. Weld joists to structural support members as required by SJI "Specifications."
- F. Touch-up Painting: Immediately after erection, solvent clean and hand- or power-tool clean (SSPC-SP 2 or SSPC-SP 3) completed field connections and damaged surfaces of shop-primed joists and adjoining structural steel. Apply corrosion-resistant touch-up paint compatible with primer.

### 3.02 FIELD QUALITY CONTROL

- A. General: Provide access for independent testing agency so that inspection can be accomplished safely.
- B. The contractor shall engage a qualified independent testing agency to perform field quality control testing as indicated below:
  - 1. Verify location, sizing, and spacing of joists.
  - 2. Perform visual inspection of all connections.
  - 3. Performance Test for K-series and LH-Series Joists: If directed by the Engineer, conduct load test in accordance with the Steel Joist Institute's (SJI) "Recommended Code of Standard Practice for Steel Joist and Joist Girders." Joists shall have bridging and top deck applied. Test panel shall sustain for one hour a test load of 1.65 times the design live load. After test load is removed, the permanent deflection shall not exceed 20 percent of the deflection under full test loading.

END OF SECTION 052100

SECTION 053100 - STEEL DECK

PART 1 - GENERAL

1.01 SUMMARY

- A. Description of scope and intent:
1. Contractor shall provide all material, labor, and tools required to complete the installation of specified system.
  2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the contractor of the obligation to provide same.
  3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  4. Installation shall be accomplished by workers skilled in their craft who will perform their work in a professional manner and will leave the premises safe, orderly and clean.
  5. Drawings and general provisions of Contract, including General and Supplemental Conditions and Division 1 Specification Sections, apply to this Section.
  6. Contractor is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees and services necessary for completion of work in this Section.
  7. In the event of a conflict between the Design Drawings, referenced standards and these Specifications, the more stringent shall govern unless directed otherwise by the Engineer. Contractor shall strictly adhere to OSHA requirements and local codes or those of any regulatory agency or body with jurisdiction.
- B. Section Includes:
1. Roof deck
- C. Related Sections:
1. Cast-in-place concrete: Elsewhere in Division 3
  2. Structural steel: Elsewhere in Division 5
  3. Steel joists: Elsewhere in Division 5
  4. Roofing: Division 7

1.02 REFERENCES

- A. ASTM A 36/A 36M-93a -- Standard Specification for Structural Steel; 1993.
- B. ASTM A 446/A 446M-93 -- Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality; 1993.
- C. ASTM A 653/A 653M-01a -- Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process; 2001.
- D. AWS D1.1-92 -- Structural Welding Code--Steel; American Welding Society; 1992.
- E. AWS D1.3-89 -- Structural Welding Code--Sheet Steel; American Welding Society; 1989.

- F. MIL P-21035B(NAVY) -- Paint, High Zinc Dust Content, Galvanizing Repair (Metric); U.S. Department of Defense; 1991.
- G. Fire Resistance Directory; Underwriters Laboratories Inc.(UL); 1994.
- H. FM P7825 -- Approval Guide 1992; Factory Mutual System; 1992 (with supplement 1).
- I. SDI Publication No. 28 -- Steel Deck Institute Design Manual for Composite Decks, Form Decks, Roof Decks, Corner Decks and Cellular Metal Floor Deck with Electrical Distribution; Steel Deck Institute, Inc.; 1992.
- J. Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute (AISI); 1986 (with 1989 Addendum and 1990 Errata).

### 1.03 SYSTEM DESCRIPTION

- A. Provide deck system which is designed and fabricated to comply with requirements of the contract documents and which strictly conforms to material, manufacturing, and erection requirements of the Steel Deck Institute's (SDI) "Standard Specifications Load Tables and Weight Tables for Steel Roof and Floor Decks" (referred to hereinafter as SDI "Specifications").
  - 1. Wind uplift and shear: Design deck and connections to comply with wind requirements indicated on structural drawings.

### 1.04 SUBMITTALS

- A. Product Data: Submit deck manufacturer's specifications and product information, indicating compliance with specified requirements.
  - 1. Include Steel Deck Institute certification of manufacturer's deck characteristics.
  - 2. Include manufacturer's certification of deck characteristics.
  - 3. Submit manufacturer's installation instructions, including specific installation sequence.
  - 4. Submit manufacturer's data on mechanical fasteners.
- B. Shop Drawings: Submit detailed drawings indicating deck types and plan layout; support locations and anchorages; projections; openings and reinforcement; and pertinent details and accessories.
- C. Calculations: Submit manufacturer's documentation of deck design loads, allowable spans, and section properties.
  - 1. Prepare calculations under seal of a professional structural engineer registered in Florida.
- D. Welder Qualifications: Submit evidence that welders employed in the work are currently certified under AWS qualification procedures.

### 1.05 QUALITY ASSURANCE

- A. Codes and Standards: Comply with requirements of the following, except where exceeded by the contract documents or requirements of governing authorities:
  - 1. AISI "Specification for the Design of Cold-Formed Steel Structural Members."



2. AWS D1.3 "Structural Welding Code--Sheet Steel."
  3. "Steel Deck Institute Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution."
- B. Qualifications: Qualify welding processes and welding operators per procedures specified in AWS D1.1.
- C. Installer: A company specializing in this type of work and with 5 years of documented experience.
- D. Testing: Welded decking in place is subject to inspection and testing by an independent agency paid by the owner. If testing indicates that welds do not comply with requirements, remove defective work, and replace at no additional expense to the owner.
- E. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.
1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
  2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- F. FM Listing: Provide roof deck units listed in Factory Mutual System's "Approval Guide" for Class I Fire-Rated and Class 1-90 windstorm construction.

#### 1.06 STORAGE AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Storage: Separate sheets and store units on dry wood sleepers, sloped to promote drainage. Cover with waterproof material ventilated to avoid condensation.
- C. Marking: Unless deck units are all the same gage and yield strength for the project, mark each unit clearly to identify differences.

### PART 2- PRODUCTS

#### 2.01 MANUFACTURERS

- A. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
1. Bowman Metal Deck/Empire Detroit Steel Division/Armco, Inc.
  2. Epic Metals Corporation.
  3. Robertson, a United Dominion Company.
  4. United Steel Deck, Inc.
  5. Vulcraft Division/Nucor Corporation.
  6. Wheeling Corrugating Company Division/Wheeling-Pittsburgh Steel Corporation.

## 2.02 MATERIALS

- A. Steel for Galvanized Metal Deck Units: ASTM A 446.
- B. Bearing Plates and Angles: ASTM A 36.
- C. Miscellaneous Steel: ASTM A 36.
- D. Sheet Metal Accessories: ASTM A 526, galvanized.
- E. Galvanizing: ASTM A 525, G60 coating where indicated.
- F. Galvanizing Repair Paint: Comply with requirements of Military Specification MIL P-21035B, Type I or II.

## 2.03 FABRICATION

- A. Roof Deck Units - General: Provide deck complying with SDI specifications for properties indicated.
- B. Standard Roof Deck Units: Comply with the following:
  - 1. Profile type: Intermediate-rib deck (Type IR).
  - 2. Material: G90 galvanized steel.
    - a. Minimum yield strength: 33,000 psi.
    - b. Minimum metal thickness: 0.028 inch.
  - 3. Spanning configuration: Multiple span.
  - 4. Sheet coverage width: 36 inches.
  - 5. Side joints: Lapped.
  - 6. Flute sides: Plain vertical faces.
- C. Eaves Plates: Fabricate of same material and gage as deck units, with flange for attachment, and with dimensions as indicated on drawings.
- D. Ridge/Valley Plates: Fabricate of same material and gage as deck units, in slope to match roof slope, not less than 4-1/2 inches wide.
- E. Fasteners: Stainless steel, self-tapping.

## PART 3- EXECUTION

### 3.01 EXAMINATION

- A. Examine field conditions and substrates to receive metal decking and verify that existing conditions are acceptable before commencing installation.

### 3.02 INSTALLATION

- A. General: Install deck units and accessories in compliance with Steel Deck Institute specifications, manufacturer's recommendations, and requirements of this specification section.

Fasten deck units to supports promptly after placement and alignment. Do not leave placed sheets unattached at end of working day.

1. Shop drawings: Comply with final shop drawings.
  2. Bearing: Follow the manufacturer's minimum recommended bearing lengths with a minimum of 6 inches at nonsteel supports and 1-1/2-inch at steel supports; align and level deck units.
  3. Placement: Place deck units flat and square, without excessive warp or deflection.
  4. End laps: Lap ends of deck units over supports and make laps not less than 2 inches.
  5. Precautions: Coordinate location of decking bundles to prevent overloading of structure.
- B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
- C. Fastening:
1. Fasten roof deck units to steel supporting members as indicated on drawings.
  2. Fasten roof deck units to nonsteel supporting members as indicated on drawings.
  3. Side laps: Fasten side laps of adjacent deck units as indicated on drawings.
  4. If not indicated on the drawings, fasten metal deck as follows:
    - a. Fasten metal deck panels to supporting members with a #12 TEK screw or equivalent at a spacing of 6" on center.
    - b. Fasten side laps and perimeter edges of panels between supports with a #10 TEK screw or equivalent at intervals not exceeding the lesser of 1/3 of the span or 36 inches.
- D. Openings:
1. Cut deck units and accessories to fit snugly around other work penetrating decks.
  2. At openings up to 18 inches in either dimension, provide reinforcement and closure strips as shown or as required for strength and rigidity.
- E. Metal Accessories: Fasten metal accessories securely to deck units, using welding or mechanical fasteners as appropriate to conditions.
1. Install metal cant strips at roof edges and as otherwise detailed.
  2. Fasten or weld metal sump pans to top deck surface at openings provided, spacing fasteners or welds at 12 inches on center maximum and with fastener or weld in each corner. Neatly cut opening for drain size indicated.
  3. Install other metal accessories as indicated.
- F. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure per SDI recommendations, unless otherwise indicated.
- G. Floor Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, per SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.
- H. Install piercing hanger tabs not more than 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides, unless otherwise indicated.
- I. Touch-up Painting: After installation of deck units and accessories, wire-brush burned and abraded areas and rust spots and apply touch-up paint.

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1. Apply galvanizing repair paint to galvanized surfaces, complying with manufacturer's instructions.

### 3.03 CLEANING

- A. Upon completion of work, remove all rubbish, debris, and excess materials from project site.

END OF SECTION 053100

## 054000 – COLD-FORMED METAL FRAMING

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Description of scope and intent:
  - 1. CONTRACTOR shall provide all material, labor, and tools required to complete the installation of specified system.
  - 2. Any omissions of reference to items required to complete the full operational and functional system specified in the section does not relieve the CONTRACTOR of the obligation to provide same.
  - 3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  - 4. Installation shall be accomplished by workers skilled in their craft that will perform their work in a professional manner and will leave the premises safe, orderly and clean.
  - 5. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this section.
  - 6. CONTRACTOR is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees, and services necessary for completion of Work in this section.
  
- B. Section Includes:
  - 1. Exterior wall framing.
  - 2. Interior load-bearing wall framing.
  - 3. Roof rafter framing.
  - 4. Roof equipment support framing.
  
- C. Related Sections include the following:
  - 1. Division 5 Section "Metal Fabrications" for masonry shelf angles and connections.
  - 2. Division 6 Section "Rough Carpentry" for sub-flooring, wall sheathing, or roof sheathing using wood-based structural-use panels, particleboard, fibrous-felted board, and foam-plastic sheathing.
  - 3. Division 9 Section "Gypsum Board Assemblies" for interior non-load-bearing metal-stud framing and ceiling-suspension assemblies.
  - 4. Division 9 Section "Gypsum Board Shaft-Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

#### 1.02 DEFINITIONS

- A. Minimum Uncoated Steel Thickness: Minimum uncoated thickness of cold-formed framing delivered to the Project site shall be not less than 95 percent of the thickness used in the cold-formed framing design. Lesser thickness shall be permitted at bends due to cold forming.
  
- B. Producer: Entity that produces steel sheet coil fabricated into cold-formed members.

### 1.03 REFERENCES

Comply with the following documents, except where requirements of the Contract Documents or of governing codes and governing authorities are more stringent. All referenced standards refer to the edition in force at the time these Drawings and Specifications are issued.

- A. ASTM A 90 -- Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- B. ASTM A 446 -- Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
- C. ASTM A 570 -- Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
- D. ASTM A 611 -- Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Structural Quality.
- E. ASTM C 1007 -- Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- F. ASTM A 653 -- Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

### 1.04 SUBMITTALS

- A. Provide submittals in accordance with Section 01300.
- B. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- C. Shop Drawings: Show layout, spacing, sizes, thickness, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining Work.
- D. Mill certificates signed by steel sheet producer indicating steel sheet complies with requirements.
- E. Welding Certificates: Copies of certificates for welding procedures and personnel.
- F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names, and addresses of architects and OWNERS, and other information specified.
- G. Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:
  - 1. Mechanical fasteners.
  - 2. Miscellaneous structural clips and accessories.

#### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer with minimum of five (5) years experience and who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Mill certificates signed by steel sheet producer indicating steel sheet complies with requirements, including uncoated steel thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and galvanized-coating thickness.
- C. Testing Agency Qualifications: Employ, at CONTRACTOR's expense, an independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- E. Fire-Test-Response Characteristics: Refer to Architectural specifications for all fire ratings.
- F. AISI Specifications: Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members" for calculating structural characteristics of cold-formed metal framing:
  - 1. CCFSS Technical Bulletin: "AISI Specification Provisions for Screw Connections."

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling. Follow all MANUFACTURER's written instruction unless otherwise noted herein.
- B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation. Follow all MANUFACTURER's written instruction unless otherwise noted herein.

### PART 2 – PRODUCTS

#### 2.01 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, MANUFACTURERS offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Dietrich Industries, Inc.

## 2.02 MATERIALS

- A. Steel Sheet: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
  - 1. Grade: As indicated on drawings.
  - 2. Coating: G90.

## 2.03 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories of the same material and finish used for framing members, with a minimum yield strength of 45,000 psi.
- B. Provide accessories of MANUFACTURER's standard thickness and configuration, unless otherwise indicated, as follows:
  - 1. Supplementary framing.
  - 2. Bracing, bridging, and solid blocking.
  - 3. Web stiffeners.
  - 4. End clips.

## 2.04 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Mechanical Fasteners: Corrosion-resistant-coated, self-drilling, self-threading steel drill screws as indicated on drawings.
- D. Welding Electrodes: Comply with AWS standards.

## 2.05 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, ASTM A 780.

## 2.06 FABRICATION

- A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to MANUFACTURER's written recommendations and requirements in this Section.
  - 1. Fabricate framing assemblies using jigs or templates.
  - 2. Cut framing members by sawing or shearing; do not torch cut.
  - 3. Fasten cold-formed metal framing members as indicated on the drawings. Wire tying of framing members is not permitted.



- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
  - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
  - 2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

### PART 3 – EXECUTION

#### 3.01 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Grout bearing surfaces uniform and level to ensure full contact of bearing flanges or track webs on supporting concrete.

#### 3.02 INSTALLATION, GENERAL

- A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed metal framing according to ASTM C 1007, unless more stringent requirements are indicated.
- C. Install cold-formed framing and securely anchor to supporting structure.
  - 1. Bolt wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to MANUFACTURER's written recommendations and requirements in this Section.
  - 1. Cut framing members by sawing or shearing; do not torch cut.
  - 2. Fasten cold-formed metal framing members by screw fastening, as standard with fabricator and indicated on drawings. Wire tying of framing members is not permitted.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

- G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- H. Install insulation in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work. Refer to architectural for insulation requirements
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of MANUFACTURER's standard punched openings.
- J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
  - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

### 3.03 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and MANUFACTURER's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to MANUFACTURER and Installer, that ensure cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 054500 - PRE-ENGINEERED LIGHT GAUGE STEEL TRUSSES

PART 1 – GENERAL

SUMMARY

- A. Description of scope and intent:
  - 1. CONTRACTOR shall provide all material, labor, and tools required to complete the installation of specified system.
  - 2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the CONTRACTOR of the obligation to provide same.
  - 3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  - 4. Installation shall be accomplished by workers skilled in their craft who will perform their work in a professional manner and will leave the premises safe, orderly, and clean.
  - 5. Drawings and general provisions of Contract, including General and Supplemental Conditions and Division 1 Specification Sections, apply to this Section.
  - 6. CONTRACTOR is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees and services necessary for completion of work in this section.
  
- B. Section includes all work and supplementary items required to complete the proper installation of the pre-engineered light gauge roof trusses as shown on the Contract Documents and specified herein including headers, outriggers, supplemental rafters, and incidental framing for a complete assembly within the extent shown on the drawings.
  
- C. Section Includes: Pre-engineered light gauge steel stud trusses consisting of welded, screwed or bolted connected members which are fabricated, cut and assembled prior to delivery.
  - 1. Gable-shaped trusses
  - 2. Monopitch trusses
  - 3. Irregular shaped trusses

1.02 REFERENCES

- A. Comply with the following documents, except where requirements of the Contract Documents or of governing codes and governing authorities are more stringent. All referenced standards refer to the edition in force at the time these plans and specifications are issued.
  - 1. AISI – American Iron and Steel Institute; Specification for the Design of Cold-Formed Steel Structural Members
  - 2. AISI – American Iron and Steel Institute; Design Guide for Cold-Formed Steel Trusses
  - 3. ASTM A370 – Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
  - 4. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
  - 5. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated by Hot-Dip Process.
  - 6. AWS D1.0 – “Code for Welding in Building Construction”.

7. ANSI Z49.1 – “Safety in Welding and Cutting”.

### 1.03 DEFINITIONS

- A. Truss Manufacturer: The approved truss manufacturer who assembles Truss Component Manufacturer’s components into complete trusses.
- B. Truss Specialty Engineer: The specialty engineer having responsibility for the design of the light gauge steel trusses.

### 1.04 SYSTEM REQUIREMENTS

- A. Design Requirements: Provide Pre-engineered light gauge steel truss system which is designed and fabricated to comply with the requirements of the Contract Documents and which strictly conforms to material, manufacturing, and erection requirements of the Truss Manufacturer, and Truss Specialty Engineer and which meets the following:
  1. Wind Uplift and Shear: Design trusses, truss to truss connections, and truss to structure connections to comply with the wind criteria indicated in the structural drawings.
  2. Gravity Loads: As indicated on the drawings.
  3. Truss Spacings: As indicated on the drawings.
  4. Fire Classification: Non-combustible
  5. Screwed Connections: Yes
  6. Interior Bearing: Yes at panel points only.
  7. Maximum Allowable Deflection: 1/240 of span, under total design loads.
  8. Maximum Allowable Deflection: 1/360 of span, under live loads only.
- B. Performance Requirements: Truss system, with framing components and accessories, shall provide a complete horizontal framing system, ready for deck installation, meeting the specified Design Requirements. Shim as required to provide uniform and smooth transitions between adjacent trusses and between trusses and walls that extend to the roof deck.
- C. Component Requirements: Truss chord and web components shall have rolled or closed edges to minimize the danger of cutting during handling. Chord and web components without rolled edges shall not be accepted.
- D. Truss Configuration: Arrangement of web member shall be at the discretion of the design engineer. Coordinate web spacing as required for mechanical duct requirements. Joint centerlines of members shall intersect at a common work point or the Specialty Engineer shall consider imposed loads due to eccentricity in the truss design.

### 1.05 QUALIFICATIONS

- A. The light gauge steel subcontractor shall have experience in fabrication and erection of light gauge steel truss and framing systems of scope and design similar to the required work.
- B. Trusses shall be designed, fabricated, and erected by a firm which has a record including a minimum of five years of successfully designing, fabricating, and erecting trussed

assemblies similar to scope required and which practices a quality control program which includes inspection by an independent inspection and testing agency acceptable to architect and authorities having jurisdiction.

- C. Manufacturers who wish to qualify for approval under this Section of the specification shall submit evidence of compliance with this specification to the Architect for acceptance.

#### 1.06 SUBMITTALS

- A. Product Data:

- 1. Submit fabricator's technical data covering materials, shapes, hardware, fabrication process, handling, and erection.
- 2. Submit certificate, signed by an officer or subcontractor or fabricating firm, indicating that trusses to be supplied for project comply with indicated requirements.

- B. Shop Drawings:

- 1. Submit shop drawings showing shapes and dimensions of members to be used including pitch, span, camber configuration and spacing for each type or configuration of truss required.
- 2. Show all bearing and anchorage details. Coordinate anchorage details with the information shown on the drawings. All anchorage to the structure shall conform to the intent of the drawings.
- 3. Specify and detail all supplemental strapping, bracing clips and other accessories required for proper installation.
- 4. Shop drawings shall include all placement sequences and instructions.
- 5. Submit design analysis and test reports indicating loading, section properties, allowable stress, stress diagrams and calculations, and similar information needed for analysis and to ensure trusses comply with requirements.
- 6. All drawings and calculations shall bear the name and seal of a Structural Engineer licensed to practice in the state of Florida.
- 7. Basis of design as indicated on drawings.

- C. Quality Assurance

- 1. Truss Manufacturer's Instructions: Printed installation instructions for each item of cold-formed metal framing and each accessory specified in this section.
- 2. Design Data: Results of design analysis, bearing the seal and signature of a professional engineer registered in the state of Florida.

- D. Qualification Data: For firms and persons who wish to qualify for approval under this section of the specifications shall submit evidence of compliance with this specification to the Architect for acceptance.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products in exact accordance with the manufacturer's latest published requirements and specifications to avoid damage from bending, overturning, or other cause for which truss is not designed to resist or endure. Storage shall be off-ground in a dry ventilated space or protect with waterproof coverings.
- B. Time the fabrication and erection of trusses to avoid extended on-site storage and to avoid

delaying work of other trades whose work must follow erection of trusses.

## 1.08 QUALITY ASSURANCE

- A. Confer at job site prior to scheduled beginning of construction activities of this section to review requirements of this section. The following at a minimum shall attend:
  - 1. Truss installer.
  - 2. Installer of truss supports.
  - 3. Mechanical CONTRACTOR.
  - 4. Electrical CONTRACTOR.
  
- B. Review potential interface conflicts:
  - 1. Coordinate layout and support provisions.
  - 2. Coordinate mechanical and electrical work.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. The following are acceptable truss manufacturers of Light Gauge Steel Truss systems:
  - 1. Alpine Engineered Products, Inc.
  - 2. Clark Steel Framing Systems.
  - 3. NuconSteel
  
- B. Request for substitutions shall be considered in accordance with provisions of Division 1. All permitted equals must be approved in writing by the ENGINEER. Do not request substitutions via the shop drawing submittal process. All applications for substitution must include samples and technical data.

### 2.02 COMPONENTS

- A. Load bearing members: Mechanical properties of components shall be determined by testing conforming to ASTM A370- Standard Test Methods and Definitions for Mechanical Testing of Steel Products. Members shall be cold-formed to indicated sizes, profiles, and thickness of steel conforming to ASTM A653, minimum G90 coating, and ASTM A500 as follows:
  - 1. Chord materials:
    - Minimum yield strength 55,000 ksi.
    - 18 gauge minimum
    - 4" minimum depth
    - Provide members of gauge and shape required for unbraced lengths to equal or exceed 5'-0".
  - 2. Web materials:
    - Minimum yield strength 45,000 ksi
    - 20 gauge minimum
    - 4" minimum depth
    - Provide members of gauge and shape required for unbraced lengths to equal or exceed 5'-0".

- B. Fasteners: All web to chord connections shall be made with the appropriate screw fasteners as recommended by the Truss Manufacturer. Number required shall be specified by Each screw shall bear the stamp of the Truss Manufacturer for ready identification. Alternate fastening methods, such as welding, are not acceptable.
- C. All trusses shall be hot-dipped galvanized using a minimum G90 coating.

## 2.03 FABRICATION

- A. General: All materials shall be clean and straight.
- B. Bridging is schematically shown on drawings. Detail and fabricate bridging in complete accordance with AISI and the Truss Manufacturers recommendations.
- C. Light Gauge Steel Trusses
  - 1. Shop fabricate from cold-formed steel components in accordance with shop drawings, using jigging systems to ensure consistent component placement and alignment of components, and to maintain specified tolerances as shown below.
  - 2. Field fabrication of trusses is strictly prohibited.
  - 3. Camber: Comply with the recommendations of the Truss Specialty Engineer.
  - 4. Shop fabrication of other cold-formed steel framing components into assemblies prior to erection is permitted.
  - 5. Splices shall not be used except as authorized by the Truss Specialty Engineer.
  - 6. Provide all clips, angles, and other miscellaneous pieces necessary to fabricate and erect the trusses and to connect trusses to the structure and to one another.

## 2.04 SOURCE QUALITY CONTROL

- A. Material Tolerances: Steel for cold-formed chord and web components:
  - 1. Nominal 20 gauge members:
    - a. Minimum bare metal thickness: 0.033 inch.
    - b. Maximum design thickness: 0.037 inch.
  - 2. Nominal 18 gauge members:
    - a. Minimum bare metal thickness: 0.043 inch.
    - b. Maximum design thickness: 0.047 inch.
  - 3. Nominal 16 gauge members:
    - a. Minimum bare metal thickness: 0.054 inch.
    - b. Maximum design thickness: 0.059 inch.
- B. Assembly Tolerances: Fabricate truss assemblies to tolerances of maximum variation from plumb, level, or true line as indicated below:
  - 1. Trusses up to 30 ft in length - maximum 1/4 inch variation from design length.
  - 2. Trusses over 30 ft in length - maximum 1/2 inch variation from design length.
  - 3. Trusses up to 5 ft in height - maximum 1/8 inch variation from design height.
  - 4. Trusses over 5 ft in height - maximum 1/4 inch variation from design height.
- C. Material Certification: Provide Truss Manufacturers material certification.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Verification of Conditions: Visually examine and verify that receiving surfaces of the substructure have no apparent defects or errors which would result in substandard workmanship. Additionally, the following items shall be installed and inspected prior to roof truss installation.
  - 1. Exterior bearing plates
    - a. Properly positioned within CMU wall cap beam.
    - b. Installed so as to allow complete and adequate contact with truss connection member.
  - 2. Interior bearing plates
    - a. Properly positioned within CMU wall cap beam or on precast hollowcore.
    - b. Installed so as to allow complete and adequate contact with truss connection member.
  - 3. Report any unsatisfactory conditions to the ENGINEER.
- B. Installer's Examination:
  - 1. Installer of this section shall inspect conditions under which construction activities of this section are to be performed, then submit written notification if such conditions are unacceptable to installer.
  - 2. Installer shall transmit two copies of inspection report to ENGINEER within 24 hours of inspection.
  - 3. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.
  - 4. Beginning construction activities of this section indicates installer's acceptance of conditions.

### 3.02 INSTALLATION

- A. Field Fastening: Use correct fastening of trusses to structure as specified by the Specialty Engineer.
- B. Metal Trusses:
  - 1. Install trusses in accordance with the Truss Manufacturer's instructions and recommendations. Place components at spacings indicated. Install temporary bracing as required. Temporary bracing shall support trusses straight and plumb and in safe condition until decking and permanent truss bracing is securely installed. All CONTRACTORS shall use proper construction procedures to insure adequate distribution of construction loads so as not to exceed design loads.
  - 2. Install required permanent bracing as indicated on the drawings in addition to the permanent bracing or bridging required by the Truss Manufacturer. All bracing and or bridging shall be installed prior to application of loads.
  - 3. Field cutting or alterations of the trusses or bracing is prohibited.
  - 4. Damaged trusses shall be repaired or replaced as directed by the Truss Specialty Engineer.
  - 5. All trusses shall be installed by approved methods using equipment of adequate capacity to safely perform the work.
  - 6. Provide web stiffeners and reinforcement at reaction points where required by the



Truss Specialty Engineer.

- C. Site Tolerances for Truss Bearings:
  - 1. Variation from level or specified plane: maximum 1/8 inch in 10 ft.
  - 2. Variation from specified position: maximum 1/4 inch.
  - 3. The CONTRACTOR shall be responsible for checking the dimensions and spacings indicated on the drawings.

3.03 FIELD QUALITY CONTROL

- A. General: CONTRACTOR shall engage a qualified independent testing agency to perform field quality control testing as indicated below:
  - 1. Verify locations, sizes, and spacing of trusses.
  - 2. Inspection of truss to truss and truss to structure connections.
- B. Provide access for independent testing agency so that inspections can be accomplished safely.

END OF SECTION 054500

## SECTION 055000 – METAL FABRICATIONS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Description of scope and intent:
  - 1. CONTRACTOR shall provide all material, labor, and tools required to complete the installation of specified system.
  - 2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the CONTRACTOR of the obligation to provide same.
  - 3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  - 4. Installation shall be accomplished by workers skilled in their craft that will perform their work in a professional manner and will leave the premises safe, orderly and clean.
  - 5. Drawings and general provisions of Contract, including EJCDC Conditions and Division 1 Specification Sections, apply to this Section
  - 6. CONTRACTOR is responsible for coordination of work included in this specification with all other specification sections related to furnishing of all materials, labor, permits, fees and services necessary for completion of work in this section.
  - 7. In the event of a conflict between the design drawings, referenced standards and these Specifications, the more stringent shall govern unless directed otherwise by the Architect. CONTRACTOR shall strictly adhere to OSHA requirements and local codes or those of any regulatory agency or body with jurisdiction
- B. This Section includes the following:
  - 1. Steel framing and supports for applications where framing and supports are not specified in other Specification Sections or on the Structural Drawings.

#### 1.02 SUBMITTALS

- A. Provide submittals in accordance with Section 013000.
- B. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
  - 1. Provide templates for anchors and bolts specified for installation under other Sections.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.

#### 1.03 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Welding: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1, "Structural Welding Code--Steel."
  - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
  - 3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Testing and Inspection:
  - 1. General: Provide access to testing and inspection agency so that specified testing and inspection can be safely accomplished.
  - 2. Shop bolted connections: Comply with testing and verification procedures in AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts," except test not less than the following number of bolts in each bolted connection: All slip critical connections as noted SC on drawings.
  - 3. Welded connections: Inspect and test welds as follows:
    - a. Visually inspect all weld.
    - b. Inspect 100 percent of full penetration welds, using test method as follows:
      - (1) Radiographic testing (ASTM E 94 and ASTM E 142).
    - c. Inspect 20 percent of fillet welds, using one of the following test methods:
      - (1) Radiographic Testing (ASTM E 94 and ASTM E 142).
      - (2) Magnetic Particle Inspection (ASTM E 709).
      - (3) Ultrasonic Testing (ASTM E 164).
      - (4) Liquid Penetrant Inspection (ASTM E 165).

#### 1.04 PROJECT CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

#### 1.05 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

### PART 2 - PRODUCTS

#### 2.01 METALS, GENERAL

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

## 2.02 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Malleable-Iron Castings: ASTM A 47, Grade 32510.
- C. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

## 2.03 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead and chromate free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

## 2.04 FASTENERS

- A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Anchor Bolts: ASTM F 1554, Grade 36.
- C. Machine Screws: ASME B18.6.3.
- D. Lag Bolts: ASME B18.2.1.
- E. Wood Screws: Flat head, carbon steel, ASME B18.6.1.
- F. Plain Washers: Round, carbon steel, ASME B18.22.1.
- G. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
  - 1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

- I. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

## 2.05 GROUT

- A. Non-shrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.

## 2.06 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Shear and punch metals cleanly and accurately. Remove burrs.
- C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- I. Remove sharp or rough areas on exposed traffic surfaces.
- J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

## 2.07 STEEL ANGLES

- A. Fabricate angles from steel angles of sizes required or indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete. Align expansion joints in angles with indicated control and expansion joints.
- C. Galvanize steel angles to be installed in all walls. All exposed exterior angles shall also be painted.

#### 2.08 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports that are not a part of structural-steel framework as necessary to complete the Work.
- B. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
  - 1. Fabricate units from slotted channel framing where indicated.
- C. Galvanize all miscellaneous framing and supports.

#### 2.09 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

#### 2.10 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
  - 1. ASTM A 123, for galvanizing steel and iron products.
  - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
  - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

### PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- G. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
  - 1. Use non-shrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations, unless otherwise indicated.
  - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### 3.02 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.

### 3.03 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.  
1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000



## SECTION 055133 - METAL STAIRS AND LADDERS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Aluminum fixed vertical ladders.

#### 1.2 RELATED SECTIONS

- A. Section 051200 - Structural Steel: Roof framing and support.
- B. Section 054000 – Cold Formed Metal Framing: Miscellaneous metal supports.
- C. Section 061000 - Rough Carpentry: Roof framing and opening support.
- D. Section 075216 - (SBS) Modified Bituminous Membrane Roofing: Roof curb flashing.

#### 1.3 REFERENCES

- A. ANSI A14.3: Ladders - Fixed - Safety Requirements.
- B. OSHA 1910.27: Fixed Ladders.
- C. American Society for Testing and Materials (ASTM) Publications:
  - 1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
  - 2. ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Shop Drawings for Ladders:
  - 1. Plan and section of ladder installation.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products until installation inside under cover. If stored outside, under a tarp or suitable cover.

#### 1.6 WARRANTY

- A. Limited Warranty: Five years against defective material and workmanship, covering parts only, no labor or freight. Defective parts, if deemed so by the manufacturer, will be replaced at no charge, freight excluded, upon inspection at manufacturer's plant which warrants same.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

1. (Basis of Design Manufacturer): Precision Ladders, LLC, which is located at: P. O. Box 2279; Morristown, TN 37816-2279; Toll Free Tel: 800-225-7814; Tel: 423-586-2265; Email: [info@PrecisionLadders.com](mailto:info@PrecisionLadders.com); Web: [www.PrecisionLadders.com](http://www.PrecisionLadders.com)
2. O’Keeffe’s, Inc.; 100 N Hill Drive, Suite 12, Brisbane, CA 94005. Toll Free Tel: (888) 653-3333. Tel: (415) 824-4900. Fax: (415) 824-5900. Email: [info@okeeffes.com](mailto:info@okeeffes.com). Web: <http://www.okeeffes.com>.
3. UPNOVR, Inc., 3 Crane Way, New Hampshire 03106
4. Requests for substitutions will be considered in accordance with provisions of Section 01600.

## 2.2 ALUMINUM FIXED VERTICAL LADDER

- A. Aluminum Fixed Vertical Ladder and Components: Ladder, cage, rest platforms, floor mounting brackets, security doors, walk-thru, and side rails.
  1. Model: Model FL -06 (16’-4” = vertical height in inches) Aluminum Fixed Vertical Ladder with Parapet Platform & Roofside Return (Basis of Design: Precision Ladders LLC.)
  2. Capacity: Unit shall support a 1500 lb (680 kg) loading without failure, and individual treads shall withstand a 3,000 lb (1361 kg) loading without failure.
  3. Performance Standard: Units designed and manufactured to meet or exceed ANSI A14.3, OSHA 1910.27 and 2015 IMC 306.5
- B. Components:
  1. Ladder Stringer: 2-1/2 inch by 1-1/16 inch by 1/8 inch (64 mm by 27 mm by 3 mm) extruded 6005-T5 aluminum channel. Pitch: 90 degrees.
  2. Ladder Tread: 2-1/4 inch by 3/4 inch by 1/4 inch (57 mm by 19 mm by 6 mm) extruded 6005-T5 aluminum with deeply serrated top surface.
  3. Ladder Mounting Bracket: 8-1/2 inch by 2 inches by 3 inches by 1/4-inch-thick (216 mm by 51 mm by 76 mm by 6 mm) aluminum angle.
  4. Walk-Thru:
    - a. Hand Rails: 1-1/4-inch (32 mm) aluminum square tube with rounded edges.
    - b. Mounting Brackets: 4 inches by 4 inches by 1/4-inch (102 mm by 102 mm by 6 mm) aluminum.
    - c. Side Rails: 42-inch (1067 mm) side rail extension for through ladder exits.
  5. Rest Platform:
    - a. 1/8-inch (3 mm) aluminum tread plate.
    - b. Platform Size: 30” inches by 48 inches (762 mm by 1219 mm) standard.
    - c. Toe Boards. 6005 T-5 aluminum.
    - d. Handrails: 1-1/4-inch (32 mm) aluminum square tube 42 inches (1067

mm) high.

6. Security Door: 0.125 inch (3 mm) 3003-H14 aluminum panel 84 inches (2134 mm) tall with padlock provision.
7. Fall Prevention System: Complete system with rail, sleeves, and harness to limit any fall to 6 inches (152 mm) or less.
8. Floor Brackets: Floor bracket at foot of each stringer, 3 by 2 by 1/4 inch (76 by 51 by 6 mm).
9. Finishes:
  - a. Standard: Mill finish on aluminum ladder components.
  - b. Optional Finishes: Anodized

### 2.3 FABRICATION

- A. Completely fabricate ladder ready for installation before shipment to the site.
- B. Completely fabricate handrail components and ship to site ready for field assembly and attachment to ladder.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- B. Examine materials upon arrival at site. Notify the carrier and manufacturer of any damage.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

### 3.3 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

***DIVISION 6***

***WOOD AND PLASTIC***

## SECTION 061000 - ROUGH CARPENTRY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Wood fascia.
- 2. Framing with dimension lumber.
- 3. Wood blocking and nailers.

- B. Related Requirements:

- 1. Section 02070; Selective Demolition: contains requirements for removal of existing materials required prior to installation of rough carpentry.

#### 1.3 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified in other sections and not exposed, unless otherwise specified.

- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

- C. Lumber grading agencies, and the abbreviations used to reference them, include the following:

- 1. NLGA: National Lumber Grades Authority.
- 2. WCLIB: West Coast Lumber Inspection Bureau.
- 3. WWPA: Western Wood Products Association.

#### 1.4 SUBMITTALS

- A. General: Submit each item on this article according to the conditions of the Contract and Division 1 Specification Sections.

- B. Product Data for the following products:

- 1. Fasteners for attachment of wood fascia to roof framing.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored and keep dry. Provide for air circulation around stacks and under coverings.

## PART 2 - PRODUCTS

### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  - 1. Factory mark each piece of lumber with grade stamp of grading agency.
  - 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
  - 3. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent maximum moisture content at time of dressing for all dimensional lumber or less, unless otherwise indicated.

### 2.2 DIMENSION LUMBER FRAMING

- A. Roof framing/blocking: No. 2 grade.
  - 1. Species:
    - a. Douglas fir- larch; NLGA.

### 2.3 MISCELLANEOUS LUMBER

- A. General: Provide lumber for support or attachment of other construction, including nailers, blocking, furring, stripping and similar members.
- B. Grade: For dimensional lumber and board sizes, provide Southern Pine No. 2 per SPIB, Douglas Fir-Larch No. 2 per WWPA/WCLIB/NLGA or better.

### 2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Carbon steel, aluminum and electroplated galvanized steel fasteners and connectors shall NOT be used in contact with treated wood.

- B. Nails: Common wire nails conforming to FS FF-N-105, hot-dip galvanized complying with ASTM A 153 or Type 304/316 stainless steel.
  - 1. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view, will receive finish materials or opposite side substrate materials will not permit proper penetration for countersinking of head.
- C. Wood Screws: Course head screws, hot-dip galvanized complying with ASTM A 153 or Type 304/316 stainless steel.
  - 1. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view, will receive finish materials or opposite side substrate materials will not permit proper penetration for countersinking of head.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
- C. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- D. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- E. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.
- F. Make tight connections between members. Install fasteners without splitting wood; pre-drill as required.
- G. Stagger joints in wood nailers and blocking from joints in underlying wood nailers and blocking.

#### 3.2 PROTECTION

- A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06100

## SECTION 061543 WOOD CEILINGS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Wood Ceilings

#### 1.02 REFERENCES

- A. AHA (American Hardboard Association) A135.4 - Basic Hardboard.
- B. ALSC (American Lumber Standards Committee) - Softwood Lumber Standards.
- C. ANSI A208.1 - Mat-Formed Wood Particleboard.
- D. APA (American Plywood Association).
- E. AWWPA (American Wood Preservers Association) C1 - All Timber Products - Preservative Treatment by Pressure Process.
- F. AWWPA (American Wood Preservers Association) C20 - Structural Lumber Fire Retardant Treatment by Pressure Process.
- G. NFPA (National Forest Products Association).
- H. RIS (Redwood Inspection Service).
- I. SPIB (Southern Pine Inspection Bureau).
- J. WCLIB (West Coast Lumber Inspection Bureau).
- K. WWPA (Western Wood Products Association).

#### 1.03 SUBMITTALS FOR REVIEW

- A. Section 013000 - Submittals: Procedures for submittals.
- B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.

#### 1.04 SUBMITTALS FOR INFORMATION

- A. Section 013000 - Submittals: Procedures for submittals.
- B. Manufacturer's Certificate: Certify that Products conform to specified requirements.



### 1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with the following agencies:
  - 1. Lumber Grading Agency: Certified by ALSC.
  - 2. Plywood Grading Agency: Certified by APA.
- B. In lieu of grade stamping exposed to view lumber and plywood, submit manufacturer's certificate certifying that products meet or exceed specified requirements.

### 1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Section 01600 - Material and Equipment: Transport, handle, store, and protect products.
- B. Protect trusses from warping or other distortion by stacking in vertical position, braced to resist movement.

## PART 2 PRODUCTS

### 2.01 CEILING / SOFFIT MATERIAL

- A. 1 x 6 Shiplab joint : AWI premium grade Cypress.

### 2.02 ACCESSORIES

- A. Fasteners and Anchors:
  - 1. Fasteners: Stainless steel.
- B. Structural Framing Connectors, Joist Hangers, and Truss Connectors: Hot dipped galvanized steel, sized to suit framing conditions, manufactured by KC Metals.
- C. Building Paper: No. 30 asphalt felt.

### 2.03 FACTORY WOOD TREATMENT

- A. Wood Preservative (Pressure Treatment): AWWPA Treatment C1 using water borne preservative with 0.25 percent retainage, Borate.
- B. Wood Preservative (Surface Application): Colored, type, manufactured by Celcore.

## PART 3 EXECUTION

### 3.01 FRAMING

- A. Set structural members level and plumb, in correct position.

- B. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Place horizontal members, crown side up.
- D. Construct load bearing framing members full length without splices.
- E. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.
- F. Coordinate curb installation with installation of decking and support of deck openings.
- G. Install plywood sheathing at all wood soffit locations. Install one layer of 30# felt over all sheathing.

3.02 SOFFIT FRAMING

- A. Install shiplab wood with concealed stainless steel nails.

3.03 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.

END OF SECTION

## SECTION 061600 - SHEATHING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Composite nail base insulated roof sheathing.
5. Subflooring.
6. Underlayment.

##### B. Related Requirements:

1. Section 061000 "Rough Carpentry" for plywood backing panels.
2. Section 072726 "Fluid-Applied Membrane Air Barriers, Vapor Permeable" for water-resistive barrier applied over wall sheathing.

#### 1.2 PREINSTALLATION MEETINGS

##### A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

#### 1.3 ACTION SUBMITTALS

##### A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

2

- A. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.
  1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
  2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
  3. Include details of interfaces with other materials that form part of air barrier.

## 2.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, including list of ABAA-certified installers and supervisors employed by Installer, who work on Project.
- B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.
- C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For the following, from ICC-ES:
  1. Wood-preservative-treated plywood.
  2. Fire-retardant-treated plywood.
  3. Foam-plastic sheathing.
  4. Air-barrier and water-resistant glass-mat gypsum sheathing.
- E. Field quality-control reports.

## 2.3 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.
  1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution.
  1. Build integrated mockups of exterior wall assembly, 150 sq. ft. (14 sq. m), incorporating backup wall construction, window, storefront, door frame and sill, ties, and other penetrations, and flashing to demonstrate crack and joint treatment and sealing of gaps,

terminations, and penetrations of air-barrier sheathing assembly.

- a. Coordinate construction of mockups to permit inspection and testing of sheathing before external insulation and cladding are installed.
  - b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
  - c. If Owner or Program Manager determines mockups do not comply with requirements, reconstruct mockups until mockups are approved.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner or Program Manager specifically approves such deviations in writing.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Testing Agency Qualifications:
1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
  2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing: an independent agency, qualified according to ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.
- D. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

## 2.4 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.
- B. Mockup Testing: Air-barrier and water-resistant glass-mat gypsum sheathing assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
  2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate according to ASTM E783.
  3. Notify seven days in advance of the dates and times when mockups will be tested.

## 2.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

### 2.2 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat all plywood unless otherwise indicated Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

### 2.3 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
  - 1. Use treatment that does not promote corrosion of metal fasteners.
  - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-

- retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
  4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all plywood unless otherwise indicated. Treat plywood indicated on Drawings, and the following:
1. Roof sheathing.
  2. Subflooring and underlayment for raised platforms.

#### 2.4 WALL SHEATHING

- A. Plywood Sheathing: DOC PS 1 Either DOC PS 1 or DOC PS 2, Exterior, Structural I Exterior Exposure 1, Structural I Exposure 1 sheathing.
1. Span Rating: Not less than 16/0 20/0 24/0 32/16.
  2. Nominal Thickness: Not less than 11/32 inch (8.7 mm) 3/8 inch (9.5 mm) 1/2 inch (13 mm).
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1, Structural I Exposure 1 sheathing.
1. Span Rating: Not less than 16/0 20/0 24/0 24/16 32/16.
  2. Nominal Thickness: Not less than 5/16-inch (7.9 mm) 3/8-inch (9.5 mm) 1/2 inch (13 mm).
- C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Gypsum.
    - b. Georgia-Pacific Gypsum LLC.
    - c. National Gypsum Company.
    - d. Temple-Inland Building Products by Georgia-Pacific.
    - e. USG Corporation.

2. Type and Thickness: Regular, 1/2-inch (13 mm) Type X, 5/8 inch (15.9 mm) thick.
3. Edge and End Configuration: V-shaped, tongue-and-groove long edges; square ends Square.
4. Size: 24 by 96 inches (610 by 2438 mm) for horizontal 48 by 96 inches (1219 by 2438 mm) for vertical 48 by 108 inches (1219 by 2743 mm) for vertical 600 by 2400 mm for horizontal 1200 by 2400 mm for vertical 1200 by 2750 mm for vertical installation.

D. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. CertainTeed Corporation.
  - b. Continental Building Products, LLC.
  - c. Georgia-Pacific Gypsum LLC.
  - d. National Gypsum Company.
  - e. Temple-Inland Building Products by Georgia-Pacific.
  - f. USG Corporation.
2. Type and Thickness: Regular, 1/2-inch (13 mm) Type X, 5/8 inch (15.9 mm) thick.
3. Size: 48 by 96 inches (1219 by 2438 mm) 48 by 108 inches (1219 by 2743 mm) 48 by 120 inches (1219 by 3048 mm) 1200 by 2400 mm 1200 by 2750 mm 1200 by 3050 mm for vertical installation.

E. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Georgia-Pacific Gypsum LLC.
  - b. USG Corporation.
  - c. Insert manufacturer's name.
2. Thickness: 5/8 inch (15.9 mm) thick.
3. Size: 48 by 96 inches (1219 by 2438 mm) 48 by 108 inches (1219 by 2743 mm) 48 by 120 inches (1219 by 3048 mm) 1200 by 2400 mm 1200 by 2750 mm 1200 by 3050 mm for vertical installation.
4. Edges: Square.
5. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
6. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) Insert value pressure difference when tested according to ASTM E2178.
7. Vapor Permeance: Minimum 20 perms (580 ng/Pa x s x sq. m) Insert value when tested according to ASTM E96/E96M, Desiccant Method, Procedure A.
8. Sheathing Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq.



- ft. (0.2 L/s x sq. m of surface area at 75 Pa) Insert value when tested according to ASTM E2357.
9. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
  10. UV Resistance: Can be exposed to sunlight for 30 90 180 Insert number days according to manufacturer's written instructions.
  11. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- F. Cementitious Backer Units: ASTM C1325, Type A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. C-Cure.
    - b. Custom Building Products.
    - c. FinPan, Inc.
    - d. USG Corporation.
    - e. Insert manufacturer's name.
  2. Thickness: 1/2-inch (12.7 mm) 5/8 inch (15.9 mm) As indicated.
- G. Fiberboard Sheathing: ASTM C208, Type IV, Grade 1 (Regular) Grade 2 (Structural) cellulosic fiberboard sheathing with square edges, 1/2-inch (13 mm) 25/32 inch (20 mm) thick.
- H. Extruded-Polystyrene-Foam Sheathing: ASTM C578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Kingspan Insulation Limited.
  2. Thickness: 3/4 inch (19 mm) 1 inch (25 mm) As indicated.
  3. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.
- I. Foil-Faced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type I or Type II, Class 2, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings shall have a flame-spread index of 25 or less when tested individually.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Atlas EPS; a Division of Atlas Roofing Corporation.

- b. Carlisle Coatings & Waterproofing Inc.
  - c. Dow Chemical Company (The).
  - d. Firestone Building Products.
  - e. Hunter Panels.
  - f. Rmax, Inc.
2. Thickness: 7/16-inch (11.1 mm) 1/2-inch (13 mm) 5/8-inch (15.9 mm) 3/4 inch (19 mm) 1 inch (25 mm) As indicated.
  3. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.

## 2.5 ROOF SHEATHING

- A. Plywood Sheathing: DOC PS 1 Either DOC PS 1 or DOC PS 2, Exterior, Structural I Exterior Exposure 1, Structural I Exposure 1 sheathing.
  1. Span Rating: Not less than 16/0 20/0 24/0 32/16 40/20 48/24.
  2. Nominal Thickness: Not less than 15/32-inch (11.9 mm) 1/2 inch (13 mm).
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1, Structural I Exposure 1 sheathing.
  1. Span Rating: Not less than 16/0 20/0 24/0 24/16 32/16 40/20 48/24.
  2. Nominal Thickness: Not less than 7/16-inch (11.1 mm) 15/32-inch (11.9 mm) 1/2-inch (13 mm) 5/8-inch (16 mm) 3/4 inch (19 mm).

## 2.6 PARAPET SHEATHING

- A. Plywood Sheathing: DOC PS 1 Either DOC PS 1 or DOC PS 2, Exterior, Structural I Exterior Exposure 1, Structural I Exposure 1 sheathing.
  1. Span Rating: Not less than 16/0 20/0 24/0 32/16 40/20 48/24.
  2. Nominal Thickness: Not less than 15/32-inch (11.9 mm) 1/2 inch (13 mm).
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1, Structural I Exposure 1 sheathing.
  1. Span Rating: Not less than 16/0 20/0 24/0 24/16 32/16 40/20 48/24.
  2. Nominal Thickness: Not less than 7/16-inch (11.1 mm) 15/32-inch (11.9 mm) 1/2-inch (13 mm) 5/8-inch (16 mm) 3/4 inch (19 mm).
- C. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Georgia-Pacific Gypsum LLC.
    - c. National Gypsum Company.

- d. Temple-Inland Building Products by Georgia-Pacific.
  - e. USG Corporation.
  - f. Insert manufacturer's name.
2. Type and Thickness: Regular, 1/2-inch (13 mm) Type X, 5/8 inch (15.9 mm) thick.
  3. Size: 48 by 96 inches (1219 by 2438 mm) 48 by 108 inches (1219 by 2743 mm) 48 by 120 inches (1219 by 3048 mm) 1200 by 2400 mm 1200 by 2750 mm 1200 by 3050 mm for vertical installation.
- D. Cementitious Backer Units: ASTM C1325, Type A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. C-Cure.
    - b. Custom Building Products.
    - c. FinPan, Inc.
    - d. USG Corporation.
    - e. Insert manufacturer's name.
  2. Thickness: 1/2-inch (12.7 mm) 5/8 inch (15.9 mm) As indicated.

## 2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. For roof parapet and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.
- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C1002.
  2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C954.

- G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

## 2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
  - 1. Adhesive shall have a VOC content of 50 g/L or less.
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
  - 4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
  - 5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
  - 6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
  2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
  3. ICC-ES evaluation report for fastener.
- D. Coordinate wall parapet roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

### 3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
1. Wall Sheathing:
    - a. Screw to cold-formed metal framing.

### 3.3 Space panels 1/8 inch (3 mm) apart at edges and ends. GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
1. Fasten gypsum sheathing to cold-formed metal framing with screws.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
  2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

- D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
- E. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
  2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.
- F. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing:
1. Install accessory materials according to sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.
    - a. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
    - b. Install transition strip on roofing membrane or base flashing, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
  2. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
  3. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
  4. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply preformed silicone extrusion, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.
    - a. Transition Strip: Roll firmly to enhance adhesion.
    - b. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
  5. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.
  6. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
  7. Seal top of through-wall flashings to sheathing with an additional 6-inch- (150-mm-) wide,

transition strip.

8. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
9. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

### 3.4 CEMENTITIOUS BACKER UNIT INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

### 3.5 FIBERBOARD SHEATHING INSTALLATION

- A. Comply with ASTM C846 and with manufacturer's written instructions.
- B. Fasten fiberboard sheathing panels to intermediate supports and then at edges and ends. Use galvanized roofing nails [ or galvanized staples]; comply with manufacturer's recommended spacing and referenced fastening schedule. Drive fasteners flush with surface of sheathing and locate perimeter fasteners at least 3/8 inch (9.5 mm) from edges and ends.
- C. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow 1/8-inch (3-mm) open space between edges and ends of adjacent units. Stagger horizontal joints if any.
- D. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

### 3.6 FOAM-PLASTIC SHEATHING INSTALLATION

- A. Comply with manufacturer's written instructions.
- B. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.
- C. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

### 3.7 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing and Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include

the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
  2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
  3. Termination mastic has been applied on cut edges.
  4. Strips and transition strips have been firmly adhered to substrate.
  5. Compatible materials have been used.
  6. Transitions at changes in direction and structural support at gaps have been provided.
  7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
  8. All penetrations have been sealed.
- D. Tests: As determined by testing agency from among the following tests:
1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
  2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783.
- E. Air barriers will be considered defective if they do not pass tests and inspections.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Prepare test and inspection reports.

END OF SECTION 061600



## SECTION 064023 – INTERIOR ARCHITECTURAL WOODWORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:

1. Plastic-laminate cabinets
2. Plastic-laminate countertops
3. Closet and utility shelving

- B. Related Sections include the following:

1. Division 06 Section “Rough Carpentry” and/or "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
2. Division 07 Section “Joint Sealants.”
3. Division 09 Section “Non-Structural Metal Framing” for reinforcements in metal- framed partitions for anchoring wood casework.
4. Division 09 Section “Resilient Base and Accessories” for resilient base applied to wood casework.
5. Division 12 Section “Simulated Stone Countertops” for cultured marble, quartz agglomerate and solid surface countertops and integral sinks.
6. Division 12 Section “Manufactured Wood Casework.”

#### 1.3 DEFINITIONS

- A. Interior Architectural Woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.
- B. Exposed Portions of Cabinets: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 42 inches (3’-6”) above floor, and surfaces visible in open cabinets including the following:
  1. Cabinet interiors at retractable doors.
  2. Cabinet interiors behind glass doors.
  3. All surfaces of pull-out writing boards.
  4. Cabinet interiors at display cases.
  5. Top of sloped cases.
- C. Semi-exposed Portions of Cabinets: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78

inches (6'-6") or more above floor are defined as semi-exposed.

- D. Concealed Portions of Cabinets: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For panel products, high-pressure decorative laminate, fire-retardant-treated materials, cabinet hardware and accessories, handrail brackets, and finishing materials and processes. Include copies of manufacturer's product data, installation instructions, accessories specified and/or other accessories required by manufacturer.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components. Comply with seismic requirement for fabrication where required.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections. Comply with seismic requirements for restraint where required.
3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, and other items installed in architectural woodwork.
4. Show grain direction of wood veneer.

- C. Samples for Verification:

1. Submit one set of three Samples of finish plywood, 8 x 10 inches in size illustrating wood grain, figure, the extent of natural characteristics (burl, knots, mineral streaks, worm tracks, vine marks, cross bars) and specified finish of each grade and species to be installed.
2. Lumber: Submit one set of three Samples of wood trim 8 inches long illustrating wood grain, figure, the extent of natural characteristics (burl, knots, mineral streaks, worm tracks, vine marks, cross bars) and specified finish of each grade and species to be installed.
3. Plastic laminates, submit one (1) Sample 8 by 10 inches, for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
4. Thermoset decorative-panels, submit one (1) Sample 8 by 10 inches, for each type, color, pattern, and surface finish, with edge banding on 1 edge.
5. Control Samples: Contractor to retain duplicate set of submitted Samples on site until the project is completed.
6. Corner pieces as follows:
  - a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
  - b. Miter joints for standing trim.
7. Exposed cabinet hardware and accessories, one unit for each type and finish.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish complete touchup kit for each type and finish of Interior Architectural Woodwork provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged woodwork finish.

## 1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop with a minimum of ten years of experience that employs skilled workers who custom-fabricate products similar to those required for size and scope of this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Fabricator's authorized representative with a minimum of ten years of experience who is trained and approved for installation of units required for the size and scope of this project.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of Interior Architectural Woodwork indicated for construction, finishes, installation, and other requirements.
- D. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Preinstallation Conference: Conduct conference at Project site prior to commencement of Shop Drawings with Contractor, Subcontractor, Architect/Designer and others, as required.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting, utility roughing-in and similar operations that could damage, soil or deteriorate woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

## 1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

## 1.9 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that Interior Architectural Woodwork can be supported and installed as indicated.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Low-Emitting Materials: Fabricate Interior Architectural Woodwork, including countertops, with adhesives and composite wood products containing no urea formaldehyde.
- C. Wood Species and Cut for Transparent Finish: Quarter sawnwalnut
- D. Wood Species for Opaque Finish: Any closed-grain hardwood.
- E. Wood Products: Comply with the following:
  - 1. Medium Density Fiberboard (MDF): ANSI A208.2, Grade MD
  - 2. Particleboard: ANSI A208.1, Grade M-3; Density -47 lbs. cu. Ft. (min.); Internal bond – 80 psi; screw holding face – 225 lbs. (min.); screw holding edge – 155 lbs.
  - 3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1
- F. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
- G. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
  - 1. Manufacturers: See “Finish Materials Listing” in the Finish Drawings.
- H. Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3 mm thick at doors and drawer fronts, 1 mm thick elsewhere, unless noted in the Drawings to the Contract Documents.
- I. Edgebanding for Thermoset Decorative Panels: PVC edgebanding complying with LMA EDG-1 and matching thermoset decorative panels.
- J. Solid-Surfacing Material: Refer to Division 12 Section “Simulated Stone Countertops” for

specifications.

## 2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
  2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
  3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
  2. Interior Type A: Low-hygroscopic formulation.
  3. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
  4. Kiln-dry materials before and after treatment to levels required for untreated materials.
- C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
  2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: Modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw- holding capacity on face and edge, 250 and 175 lbf, respectively.
  3. Product: Subject to compliance with requirements, provide "Duraflake FR" by Weyerhaeuser.
- D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.
1. Product: Subject to compliance with requirements, provide "[Meditate FR](#)" by [SierraPine](#)

## 2.3 CABINET HARDWARE AND ACCESSORIES

- A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.
- B. Butt Hinges (at MRI Room only): Heavy duty, five knuckle 2-3/4 inch institutional type hinge. Mill ground, hospital tip, tight pin feature with all edges eased. Hinge to be full wrap around type of tempered steel .093 inch thick. Each hinge to have minimum nine screws, #7, 5/8 inch FHMS to assure positive door attachment. Provide 2 hinges for doors less than 48 inches high and 3 hinges for doors more than 48 inches high. Finish to match cabinet pulls.
1. Provide [Rockford Process Controls #376-SS](#), Type #304-SS Finish at MRI Rooms.
- C. Frameless Concealed Hinges (European Type – all other locations): BHMA A156.9, Type B01602, 170 degrees of opening, self-closing and fitted with silencer bumpers. Fully adjustable for clockwise, counter-clockwise, toe-in and out door alignment.
- D. Pocket Door Slide System: [Hafele No. RP 42/60](#), Nickel-Plated, size as required.
- E. Pulls: ADA compliant satin chrome-plated wire pulls, fastened from back with two screws. For sliding doors, provide recessed satin chrome-plated flush pulls. Provide 2 pulls for drawers more than 24 inches wide.
1. Stainless Steel: ADA compliant, Type 304 S.S. (non-ferrous) at MRI rooms.
- F. Door Catches: Dual, self-aligning, permanent magnet catch. Provide 2 catches on doors more than 48 inches high.
1. Provide non-ferrous nylon roller spring-catch at MRI Rooms.
- G. Drawer Slides: BHMA A156.9, Type B05091
1. Type:
    - a. Standard Duty (Grade 1 - 75 lbs.): Side mounted 3/4 extension type; zinc-plated steel with polymer rollers.
    - b. Heavy Duty (Grade 1HD-100 - 100 lbs. and Grade 1HD-200 - 200 lbs.): Side mounted; full-extension type; zinc-plated, steel ball-bearing slides.
  2. Uses:
    - a. Box Drawer Slides: Grade 1HD-100, for drawers not more than 6 inches high and 24 inches wide.
    - b. File Drawer Slides: Grade 1HD-200, for drawers more than 6 inches high or 24 inches wide.
    - c. Lateral File Drawer Slides: Grade 1HD-200.

- d. Pencil Drawer Slides: Grade 1, for drawers not more than 3 inches high and 24 inches wide.
  - e. Keyboard Slides: Grade 1, for computer keyboard shelves.
  - f. Trash Bin Slides: Grade 1HD-100, for trash bins not more than 20 inches high and 16 inches wide and weights of less than 100 pounds.
- H. Drawer and Hinged Door Locks: Finish to match cabinet pulls.
- 1. Cylindrical (cam) type, 5-pin tumbler, brass with chrome-plated finish, and complying with BHMA A156.11, Grade 1.
  - 2. Provide a minimum of two keys per lock and six master keys.
  - 3. Provide locks where indicated.
  - 4. Casework subcontractor to coordinate with Owners areas to be keyed alike.
- I. Sliding-Door Hardware Sets: [Johnson Hardware 2204F Series](#), size as required.
- J. Adjustable Shelf Supports:
- 1. 2-pin locking plastic shelf rests complying with BHMA A156.9, Type B04013
- K. Grommets for Cable Passage through Countertops: Doug Mockett and Company, [EDP3 Flip-Top Series 2-1/2 inch Grommet](#) Warm Grey
- L. Workstation Brackets: [A&M Hardware 1/8" Steel ADA Compliant Brackets](#), size as required.
- 1. Pre-Primed Finish
- M. Wire Manager: [Doug Mockett and Company Large J-Shape Wire Manager with Flange No. WM22A](#). Install per manufacturers' recommendations for double-sided tape installation.
- 2.4 MISCELLANEOUS MATERIALS
- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
  - B. Furring, Blocking, Shims, and Hanging Strips: Provide fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content at areas indicated or as required by codes and/or Authorities Having Jurisdiction.
  - C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- 2.5 FABRICATION, GENERAL
- A. Interior Woodwork Grade: Unless otherwise indicated, provide custom-grade interior woodwork complying with referenced quality standard.

- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication as per manufacturer recommendations.
- D. Fabricate woodwork to dimensions, profiles, and details indicated.
  - 1. Provide two layers 3/8" bendable substrate at curved and/or radiused surfaces.
- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
  - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
  - 1. Seal edges of openings in countertops with a coat of varnish.
- G. Install glass to comply with applicable requirements in Division 08 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.
- H. Interior Architectural Millwork ends to be self-returned with no end grain showing.
- I. Applied moldings to be shop applied with spot glue and finish nails. Finish nails to be filled and sanded.
- J. Hardware to be installed neatly without tear-out of surrounding stock.
- K. CABINET FABRICATION
  - 1. Sub-Base: To be separate and continuous (no cabinet body sides-to-floor), water-resistant exterior grade plywood with concealed fastening to cabinet bottom. Ladder-type construction of front, back and intermediates, to form a secure and level platform to which cabinets attach.
  - 2. Dividers: 3/4-inch vertical and horizontal dividers. Provide structural dividers in cabinets over 36 inches wide.
  - 3. Drawers: Provide 1/2-inch drawer bottoms glued and dadoed into front, back and sides of drawers.
    - a. Reinforce drawer bottoms with 1/2-inch x 4-inch front-to-back intermediate underbody stiffeners. One at 24 inches, two at 36 inches, and 4 at 48 inches.



4. Drawer Fronts: Applied to separate drawer body component subfront.
5. Shelves: 3/4-inch at shelves up to 36 inches wide; 1 inch at shelves 36 inches wide and greater.
  - a. Fixed shelves shall be fully-bound (dadoed or dowelled) at vertical dividers.
6. Doors:
  - a. Stile and rail glass doors – all exposed edges to be trimmed and glazed with extruded vinyl glazing bead.
    - 1) 1/4" tempered float glass
  - b. Frameless sliding glass doors shall be 1/4-inch tempered float glass with polished edges fit with anodized aluminum shoes and nylon rollers.
  - c. Sliding Wood Doors: Minimum 3/4-inch.
7. Backs of Cabinets: 1/2-inch
  - a. Rear, unexposed, side of back to receive continuous industrial grade hot melt glue at joint between back and sides/top/bottom for sealing against moisture and vermin, and further contribute to case rigidity.
  - b. Cabinet back shall be fully-bound (dadoed) into sides, top and bottom.
  - c. Provide 3/4-inch hang rails at rear of cabinet back and fastened to cabinet sides. Provide minimum of two at base, two at wall and three at tall cabinets.
8. Cabinet Ends: Holes drilled for adjustable shelves to accept 2-pin locking plastic shelf rests
9. Dust Panels:
  - a. 1/2-inch plywood above compartments and drawers, unless located directly under tops.

## 2.6 PLASTIC-LAMINATE CABINETS

- A. Grade: Premium
- B. AWI Type of Cabinet Construction: Flush overlay
- C. Laminate Cladding for Exposed Surfaces:
  1. Plastic Laminate: [Grade VGS](#)
  2. Unless otherwise indicated, provide specified edgebanding on all exposed edges.
  3. Direction of wood grain plastic laminates at door and drawer faces to be vertical.
- D. Materials for Semi-exposed Surfaces:
  1. Plastic Laminate: Grade CLS

- a. Provide plastic laminate for interior faces of doors and drawer fronts and to balance exposed cabinet ends.
  - 2. Thermoset Decorative Panels: Provide thermoset decorative panels for semi-exposed surfaces unless otherwise indicated.
    - a. White
  - 3. Unless otherwise indicated, provide specified edgebanding on all semi-exposed edges.
- E. Concealed Cabinet Materials: Plastic laminate, GradeBKL
- F. Colors, Patterns, and Finishes: See “Finish Materials Listing” in the Finish Drawings.
- G. PVC Edgebanding Color: See “Finish Materials Listing” in the Finish Drawings.
- H. Cabinet Fabrication:
- 1. Plastic-Laminate-Faced Cabinet Construction: As required by referenced quality standard, but not less than the following
    - a. Cabinet Sub-Base: To be separate and continuous (no cabinet body sides- to-floor), water-resistant exterior grade plywood with concealed fastening to cabinet bottom. Ladder-type construction of front, back and intermediates, to form a secure and level platform to which cabinets attach.
      - 1) Cabinet sub-base to be 4” high unless noted in the Drawings.
    - b. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semi-exposed surfaces.
      - 1) Provide solid sub-top for all base cabinets.
    - c. Shelves: 3/4-inch particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semi-exposed surfaces at shelves up to 36 inches wide; 1 inch particle board at shelves 36 inches wide and greater.
      - 1) Fixed shelves shall be fully-bound (dadoed) at vertical dividers.
      - 2) Provide 1 mm edge banding.
    - d. Backs of Cabinets: 1/2-inch particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semi-exposed surfaces.
      - 1) Rear, unexposed, side of back to receive continuous industrial grade hot melt glue at joint between back and sides/top/bottom for sealing against moisture and vermin, and further contribute to case rigidity.
      - 2) Cabinet back shall be fully-bound (dadoed) into sides, top and bottom.
      - 3) Provide 3/4-inch hang rails at rear of cabinet back and fastened to cabinet sides. Provide minimum of two at base, two at wall and three at tall cabinets.
    - e. Drawer Fronts: 3/4-inch particleboard, plastic-laminate faced, applied to separate

- drawer body component sub-front.
  - f. Drawer Sides and Backs: 1/2-inch thermoset decorative panels, with glued dovetail or multiple-dowel joints.
  - g. Drawer Bottoms: 1/2-inch thermoset decorative panels glued and dadoed into front, back, and sides of drawers.
    - 1) Reinforce drawer bottoms with 1/2-inch x 4-inch front-to-back intermediate underbody stiffeners. One at 24 inches, two at 36 inches, and 4 at 48 inches.
    - 2) Paper storage drawers to be fitted with hood at back.
  - h. Doors: 3/4-inch particleboard or MDF with wood stiles and rails, plastic-laminate faced.
    - 1) Stile and rail glass doors - all exposed edges to be trimmed and glazed with extruded vinyl glazing bead. Glazing bead to be black unless noted in the Finish Materials Listing in the Finish Drawings.
      - a) 1/4" tempered glass
  - i. Frameless sliding glass doors shall be 1/4-inch tempered glass with polished edges fit with anodized aluminum shoes and nylon rollers.
  - j. Cabinet Ends: 3/4-inch particle board, plastic laminate-faced.
    - 1) Holes drilled for adjustable shelves to accept twin pin design shelf supports with anti-tip-up shelf restraints.
    - 2) Library stack end panels to be 1-inch.
  - k. Vertical and Horizontal Dividers: 3/4-inch particle board, plastic laminate-faced on exposed surfaces, thermoset decorative panels on semi-exposed surfaces secured with molded plastic clips or dowels. Provide structural dividers in cabinets over 36 inches wide.
  - l. Door/Drawer Front Rail: 3/4-inch x 6-inch full width cabinet body rails immediately behind all door/drawer and multiple drawer horizontal joints to maintain exact body dimensions and close off reveal.
- l. Filler Strips: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment, minimum 1-inch; maximum 3-inch. Fabricate from same material and with same finish as cabinets. On wall-to-wall elevations, center the cabinets with equal filler strips on both ends.
- J. Dust Panels:
- 1. 1/2-inch particle board above compartments and drawers, unless located directly under tops.

## 2.7 PLASTIC-LAMINATE COUNTERTOPS

- A. Grade: Premium
- B. Countertops, General: Provide smooth, clean exposed tops and edges in uniform plane free of defects. Provide front and end overhang of 1 inch over base cabinets.

- C. Plastic-Laminate Tops: Plastic-laminate sheet, shop bonded to both sides of plywood or particleboard. Sand surfaces to which plastic laminate is to be bonded. See Drawings for countertop thickness.
  - 1. Plastic Laminate for Formed Tops: [Grade HGP](#). Provide formed tops unless noted in the Drawings to the Contract Documents.
    - a. Construct top and backsplash from one piece of plastic laminate with rolled edges and coved intersection. Where indicated, provide separate end splashes fitted to top.
  - 2. Plastic Laminate for Flat Tops: [Grade HGS](#)
    - a. Provide edge banding material per details.
  - 3. Plastic Laminate for Backing: Grade BKL
  - 4. Use exterior plywood for countertops containing sinks.

## 2.8 SOLID-SURFACING-MATERIAL COUNTERTOPS

- A. Grade: Refer to Division 12 Section “Simulated Stone Countertops” for specifications.

## 2.9 CLOSET AND UTILITY SHELVING

- A. Wood Shelving for Opaque Finish
  - 1. Grade: Custom
  - 2. Shelf Material: 3/4-inch solid lumber at shelves up to 36 inches wide; 1 inch at shelves 36 inches wide and greater
  - 3. Cleats: 3/4-inch solid lumber
  - 4. Wood Species: Any closed-grain hardwood
  - 5. Standards: [Knap & Vogt #85 Series](#) Anachrome
  - 6. Brackets: [Knap & Vogt #185 Series](#) Anachrome

## 2.10 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- C. General: Shop finish transparent-finished Interior Architectural Woodwork at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing opaque-finished architectural woodwork.
- D. Shop Priming: Shop apply the prime coat including back-priming, if any, for items specified to be field finished. Refer to Division 09 painting Sections for material and application requirements.

- E. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
  - 1. Back-priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require back-priming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
- F. Transparent Finish:
  - 1. Grade: Finish to match grade of Interior Architectural Woodwork.
  - 2. AWI Finish System: Conversion varnish
  - 3. Staining: Match Architect's sample.
  - 4. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
  - 5. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
    - a. Apply wash-coat sealer after staining and before filling.
    - b. Sand between each coat.
  - 6. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back-priming.

### 3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

- E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated. Comply with seismic requirements for restraint where required.
- G. Cabinets:
  - 1. Install level, plumb, and true; shim as required, using concealed shims. Where manufactured wood casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
  - 2. Maintain veneer sequence matching of cabinets with transparent finish.
  - 3. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Fasten cabinets to masonry or framing, wood blocking, or reinforcements in walls and partitions with fasteners spaced 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
    - a. Where base cabinets are not installed adjacent to walls, fasten to floor at toe space with fasteners spaced 16 inches o.c. Secure sides of cabinets to floor, where they do not adjoin other cabinets, with not less than two fasteners.
  - 4. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, or framing, blocking, or reinforcements in walls or partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
    - a. Fasten through back, near top and bottom, at ends, and not more than 16 inches o.c.
    - b. Use toggle bolts at hollow masonry.
    - c. Use expansion anchors at solid masonry.
    - d. Use No. 10 wafer-head screws sized for 1-inch penetration at wood hanging strips.
    - e. Use No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish at metal-framed partitions.
    - f. Use toggle bolts at plaster on metal lath.
  - 5. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
  - 6. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
- H. Countertops:
  - 1. Field Jointing: Where possible make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.

- a. Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
  - 2. Secure tops to cabinets with Z- or L-type fasteners or equivalent, using two or more fasteners at each front, end, and back.
  - 3. Abut top and edge surfaces in one true plane, with internal supports placed to prevent deflection.
  - 4. Secure backsplashes and end splashes to tops with concealed metal brackets at 16 inches o.c. and walls with adhesive.
  - 5. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.
- I. Shelving:
- 1. Securely fasten shelf standards to masonry, partition framing, wood blocking, or reinforcements in partitions. Comply with seismic requirements for installation where required.
    - a. Fasten shelf standards at ends and not more than 12 inches o.c.
    - b. Use toggle bolts at hollow masonry.
    - c. Use expansion anchors at solid masonry.
    - d. Use self-tapping sheet metal screws in metal framing or metal backing at metal-framed partitions. Do not use wall anchors in gypsumboard.
    - e. Use toggle bolts at plaster on metal lath.
  - 2. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Space standards not more than 36 inches o.c. between standards and 18 inches from shelf ends.
  - 3. Install shelving level and straight, closely fitted to other work where indicated.
- J. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

### 3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064023

## SECTION 064660 - PLASTIC FABRICATIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the Plastic Fabrication as shown and specified in the described system(s):
  1. Light Box with translucent Resin Panel
  2. Bracket Supported Wall Panels

#### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data; include product description, fabrication information, and compliance with specified performance requirements.
  - B. Submit product test reports from a qualified independent 3<sup>rd</sup> party testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed test reports will be acceptable if for current manufacturer and indicative of products used on this project.
    1. Test reports required are:
      - a. Rate of Burning (ASTM D 635)
      - b. Self-Ignition Temperature (ASTM D 1929)
      - c. Density of Smoke (ASTM D 2843)
      - d. Flame spread and Smoke developed testing (ASTM E 84)
      - e. Room Corner Burn Test (NFPA 286)
      - f. Extent of Burning (UL 94)
      - g. Impact strength (ASTM D 3763)
      - h. Safety glazing impact resistance (ANSI Z97.1-2004)
      - i. UPITT Test for Combustion Product Toxicity
      - j. Dynamic environmental testing (ASTM standards D 5116 and D6670)
  - C. Shop Drawings: Include plans, elevations, sections, panel dimensions, details, and attachments to other work.
  - D. Samples for Initial Selection:
    1. Submit minimum 7-inch by 7-inch samples. Indicate full color, texture and pattern variation.
  - E. Maintenance Data: Submit manufacturer's care and maintenance data, including care, repair and cleaning instructions. Include in Project closeout documents.
- #### 1.4 QUALITY ASSURANCE
- A. Manufacturers Qualifications
    1. Materials and systems shall be manufactured by a company continuously and



regularly employed in the manufacture of specified materials for a period of at least five (5) consecutive years and which can show evidence of those materials being satisfactorily used on at least six (6) projects of similar size, scope and location. At least three (3) of the projects shall have been successful for use five (5) years or longer.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver Plastic Fabrications, systems and specified items in manufacturer's standard protective packaging.
- B. Do not deliver Plastic Fabrications, system, components and accessories to Project site until areas are ready for installation.
- C. Store materials in a flat orientation in a dry place that is not exposed to exterior elements.
  - 1. Store curved elements in accordance with manufacturer's recommendations.
- D. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent damage or staining following installation for duration of project.
- E. Before installing Plastic Fabrications, permit them to reach room temperature.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install Solid Polymer Fabrications until ambient temperatures and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

#### 1.7 WARRANTY

- A. Manufacturer's Special Warranty on Plastic Fabrications: Manufacturer's standard form agreeing to repair or replace units that fail in material or workmanship within the specified warranty period.
- B. Warranty Period: 1 year after the date of substantial completion.
- C. The warranty shall not deprive the owner of other rights or remedies the Owner may have under other provisions of the Contract Documents, and is in addition to and runs concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Manufacturer: 3form, Inc., Salt Lake City, Utah, USA / telephone 801-649-2500
- B. Varia™ produced from ecoresin™ Sheet
  - 1. Engineered polyester resin
  - 2. Sheet Size: Maximum 4' x 10'
  - 3. Thickness: As indicated on drawings
  - 4. Product: The design of Plastic Fabrications is based on Varia™ produced with ecoresin™ as provided by 3form, Inc.
- C. Interlayer Materials: Compatible with polyesters and bonding process to create a monolithic sheet of material when complete.

D. Sheet minimum performance attributes:

1. Rate of Burning (ASTM D 635). Material must attain CC1 Rating for a nominal thickness of 1.5 mm (0.060 in.) and greater.
2. Self-Ignition Temperature (ASTM D 1929). Material must have a Self-ignition temperature greater than 650°F.
3. Density of Smoke (ASTM D 2843). Material must have a smoke density less than 75%.
4. Flame spread and Smoke developed testing (ASTM E 84). Material must be able to meet a level of Class A (Flame spread less than 25 and smoke less than 450) at thickness of 1”.
5. Room Corner Burn Test (NFPA 286). Material must meet Class A criteria at ¼” thickness as described by the 2003 *International Building Code*.
6. Extent of Burning (UL 94). Must submit UL card.
7. Impact strength. Minimum impact strength test as measured by ASTM D 3763 of 20 ft. lbs. (for durability, shipping, installation, and use).
8. Safety Glazing. Material must attain a Class A impact rating in accordance with ANSI Z97.1-2004 at 1/8” thickness.
9. UPITT Test for Combustion Product Toxicity: Product must be recorded as “not more toxic than wood”.
10. Dynamic environmental testing (ASTM standards D 5116 and D 6670). Panels must not have detectable VOC off-gassing agents and must be have Greenguard™ Indoor Air Quality certified.

2.2 BRACKETS

- A. Product: As identified on the Drawings.

2.3 LIGHT BOX

- A. Manufacturer: 3form, Inc., Salt Lake City, Utah, USA / telephone 801-649-2500
- B. 3form Light Box™: Aluminum framed LED edge-light carrying panel to back light a translucent panel with dimming capability.

2.4 FABRICATION

- A. General: Fabricate Plastic Fabrications to designs, sizes and thicknesses indicated and to comply with indicated standards. Sizes, profiles and other characteristics are indicated on the drawings.
1. Polish all exposed edges and radius outside corners where indicated. Ease all exposed edges 1/32 inch.
  - 2.
- B. Comply with manufacturer’s written recommendations and the following for fabrication:
1. Polish all exposed edges and radius outside corners where indicated.
  2. Ease all exposed edges 1/32 inch.
  3. Oversize hole diameter for material penetrating through plastic by 1/8 inch.
- C. Machining: Acceptable means of machining are listed below. Ensure that material is not chipped or warped by machining operations.
1. Sawing: Select equipment and blades suitable for type of cut required.
  2. Drilling: Drills specifically designed for use with plastic products.
  3. Milling: Climb cut where possible.

4. Routing
  5. Tapping
- D. Forming: Form products to shapes indicated using the appropriate method listed below. Comply with manufacturer's written instructions.
1. Cold Bending
  2. Hot Bending
  3. Thermoforming: Acceptable only on uncoated material.
  4. Drape Forming
  5. Matched Mold Forming
  6. Mechanical Forming

## 2.5 MISCELLANEOUS MATERIALS

- A. General: Provide products of material, size, and shape required for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaner: Type recommended by manufacturer.
- C. Fasteners: Use fasteners appropriate to the application and as approved by the manufacturer.
- D. Bonding Cements: May be achieved with solvents or adhesives, suitable for use with product and application.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where installation of Plastic Fabrications will occur, with Installer present, for compliance with manufacturer's requirements. Verify that substrates and conditions are satisfactory for installation and comply with requirements specified.

### 3.2 INSTALLATION

- A. General: Comply with manufacturer's written instructions for the installation of Plastic Fabrications.
- B. Manufacturer's shop to fabricate items to the greatest degree possible.
- C. Utilize fasteners, adhesives and bonding agents recommended by manufacturer for type of installation indicated. Material that is chipped, warped, hazed or discolored as a result of installation or fabrication methods shall be replaced.
- D. Install components plumb, level and rigid, in accordance with approved shop drawings and product data.
- E. Form field joints using manufacturer's recommended procedures. Locate seams in panels so that they are not directly in line with seams in substrates.

### 3.3 BRACKET SUPPORTED PANELS

- A. Install panels using mounting brackets indicated. Secure mounting brackets to top of wall. Shim between bracket and plastic fabrication with resilient material recommended by the manufacturer and to provide even bearing of plastic panel across

each bracket.

- B. Shim and oversize hole in plastic fabrication shall be such that the plastic fabrication is not supported on and does not touch the penetrating anchor of the bracket.
  - C. Polish and ease edges and radius corners as indicated.
- 3.4 ALUMINUM FRAMED PANELS
- A. Install panel in aluminum framing in accordance with manufacturer's recommendations.
  - B. Secure framing to floor, wall and ceiling structure using ¼ inch diameter anchors appropriated to the construction and at not more than 16 inches oc.
- 3.5 TOP SUPPORTED WALL PANELS
- A. Install panel in aluminum top support trim in accordance with manufacturer's recommendations.
  - B. Secure support trim to ceiling structure using ¼ inch diameter anchors appropriated to the construction and at not more than 16 inches oc.
  - C. Polish and ease edge exposed edges.
- 3.6 CLEANING AND PROTECTION
- A. Protect surfaces from damage until date of substantial completion. Repair work or replace damaged work, which cannot be repaired to Architect's satisfaction.

END OF SECTION

## SECTION 066140 - SOLID SURFACE FABRICATIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Furnish labor, materials, tools and other equipment, and services necessary to provide solid surface fabrications, including all components and accessory items required for a complete installation.
  - 1. Window sills
- B. Work under this Section also includes moisture and alkalinity testing, and surface preparation of substrates as required for acceptance of solid surface fabrication including but not necessarily limited to, cleaning, small crack repair, patching, filling, any other work required to provide an appropriate substrate
- C. This Specification shall be supplemented by any applicable federal, state and local building codes, guidelines, regulations, and standards adopted in the immediate geographic area of the Project; insurance rating organizations; including all other Authorities Having Jurisdiction.

#### 1.3 RELATED SECTIONS

- 1. Division 05 Section "Metal Fabrications" for metal blocking.
- 2. Division 06 Section "Miscellaneous Rough Carpentry" and/or "Rough Carpentry" for wood blocking.

#### 1.4 REFERENCE STANDARDS

- 1. International Solid Surface Fabricators Association (ISSFA)
  - a. ISSFA-2: Classification and Standards Publication of Solid Surfacing Material

#### 1.5 ACTION SUBMITTALS

- A. Submit items in accordance with Division 01 Section "Submittal Procedures"
- B. Product Data: For each type of product indicated, submit copies of manufacturer's product data, installation instructions and accessories specified and/or required by manufacturer.

- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
  - 1. Show full size details, edge details, thermoforming requirements and attachments.
  - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Section.
  - 3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, and other items installed in solid surface fabrications.
  - 4. Samples for Verification:
    - a. Submit two (2) six-inch square samples of each color and finish.
    - b. Submit sample showing inconspicuous seam representation.
    - c. Manufacturers joint sealant for wainscoting/paneling.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of solid surface material, provide manufacturer's care and maintenance data, including repair and cleaning instructions.
  - 1. Provide maintenance kit for each finish.

#### 1.7 QUALITY ASSURANCE

- A. Qualification Data: Verify Installer is qualified and approved by Manufacturer/Supplier, with a minimum of five years of continuous, uninterrupted experience in successfully installing work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who agrees to employ only skilled tradesmen with a minimum of five years of experience.
- B. Source Limitations: Obtain solid surface fabrications with all accessory products, from single source from single manufacturer.
- C. Fire Test Response Characteristics: Provide with the following Class A (Class I) surface burning characteristics as determined by testing identical products per ASTM E84, UL 723, or another testing and inspecting agency acceptable to Authorities Having Jurisdiction.
  - 1. Flame Spread Index: 25 or less
  - 2. Smoke Developed Index: 450 or less
- D. Mock-Ups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Preinstallation Conference: Conduct conference at Project site prior to commencement of Shop Drawings to comply with Contractor, Subcontractor, Architect/Designer and others, as required.

## 1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install solid surfacing fabrications until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at design levels during the remainder of the construction period.
- B. Field Measurements: Where solid surface fabrication is indicated to fit to other construction, certify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurement on Shop Drawings.

## 1.9 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that solid surface fabrication can be supported and installed as indicated.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Solid Surface Materials: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.
- B. Colors and Patterns: See Finish Materials Listing in the Finish Drawings.
- C. Edge Treatment: As indicated in the Drawings.
- D. Thickness: See Finish Materials Listing in the Finish Drawings.
- E. Finish: See Finish Materials Listing in the Finish Drawings.
- F. Inlays: Fabricate using manufacturer's written recommendations.

### 2.2 ACCESSORIES

- A. Joint Adhesive: Manufacturer's standard to create inconspicuous, nonporous joints.
  - 1. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Contact Adhesive: 250 g/L.

- b. Wood Glues: 30 g/L.

## 2.3 FABRICATION

- A. Fabricate solid surface to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- C. Recess and conceal fasteners, connections, and reinforcing.
- D. Design construction and installation details to allow for expansion and contraction of materials.
- E. Form joints between components using manufacturer's standard joint adhesive with tight, non-conspicuous, hairline joints.
- F. Fabricate items to profiles shown with connections and supports as indicated, or as required for complete installation in accordance with manufacturer's written instructions.
- G. Rout and finish component edges with clean, sharp returns. Rout cutouts, radii and contours to template.
- H. Do not exceed manufacturer's recommended unsupported overhang distances.
- I. Finish exposed surfaces smooth and polish to sheen specified.
- J. Windowsills: 1/2-inch-thick with eased edges.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. With Installer present, examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
    - a. Beginning of installation means Installer accepts existing surface and/or substrate conditions.

### 3.2 INSTALLATION

- A. General: Install in accordance with manufacturer's written installation instructions.
  - 1. Install components plumb, level and rigid scribed to adjacent finishes.
  - 2. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.



- a. Exposed joints/seams are not acceptable.
  - 3. Cut and finish component edges with clean, sharp returns.
  - 4. Rout radii and contours to template.
  - 5. Carefully dress joints smooth, remove surface scratches and clean entire surface.
- B. Window Sills: Install sills tight to window framing and adjacent wall surfaces. Anchor with concealed fastening system to securely prevent rocking, racking, or displacement. Seal joint between sill at adjacent wall and window surfaces with Sealant as specified in Division 07 Section "Joint Sealants."
- C. Tolerances:
- 1. Maximum Variation From True Dimension: 1/8-inch
  - 2. Maximum Offset From True Position: 1/8-inch
- 3.3 REPAIR
- A. Replace damaged work which cannot be repaired to Architect's satisfaction.
- 3.4 CLEANING AND PROTECTION
- A. Cleaning:
- 1. Clean and polish fabrications in accordance with manufacturer's instructions.
  - 2. Promptly remove excessive mastic and seam adhesive.
- B. Protection:
- 1. Do not permit construction near unprotected surfaces.
  - 2. Refer to manufacturer's warranty and exclusions as stated herein.

END OF SECTION 066140

***DIVISION 7***

***THERMAL AND MOISTURE PROTECTION***

## SECTION 072100 THERMAL INSULATION

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Board insulation at cavity wall construction.
- B. Batt insulation for interior wall partitions and filling perimeter window and door shim spaces and crevices in exterior wall and roof.

#### 1.2 RELATED REQUIREMENTS

- A. Section 042200 – Reinforced Unit Masonry: Masonry walls enclosing insulation.
- B. Section 042113 – Brick Veneer Masonry: Masonry walls enclosing insulation.
- C. Section 047200 Cast Stone Masonry: Masonry walls enclosing insulation.
- D. Section 054000 - Cold-Formed Metal Framing: Board insulation as wall sheathing.
- E. Section 072726 "Fluid-Applied Membrane Air Barriers, Vapor Permeable": Separate air barrier and vapor retarder materials.
- F. Section 075216 "SBS Modified Bituminous Membrane Roofing" for installing sheet metal flashing and trim integral with membrane roofing.
- G. Section 078400 - Firestopping: Insulation as part of fire-rated through-penetration assemblies.
- H. Section 092216 – Non-Structural Metal Framing: Acoustic insulation inside walls and partitions.
- I. Section 092900 - Gypsum Board: Acoustic insulation inside walls and partitions.

#### 1.3 REFERENCE STANDARDS

- A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2015a.
- B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- D. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C; 2012.
- E. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012.

#### 1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

#### 1.5 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

### PART 2 PRODUCTS

#### 2.1 APPLICATIONS

- A. Insulation Inside Masonry Cavity Walls: Extruded polystyrene board.

## 2.2 FOAM BOARD INSULATION MATERIALS

- A. Extruded Polystyrene Board Insulation: Extruded polystyrene board; ASTM C578; with either natural skin or cut cell surfaces, and the following characteristics:
1. Type: ASTM C578.
  2. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
  3. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
  4. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
  5. R-value; 1 inch of material at 72 degrees F: 4.1, minimum.
  6. Complies with fire resistance requirements shown on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
  7. Board Size: 24 x 96 inch.
  8. Board Thickness: 1-1/2 inches.
  9. Board Edges: Square.
  10. Compressive Resistance: 25 psi.
  11. Board Density: 1.3 lb/cu ft.
  12. Water Absorption, Maximum: 0.3 percent, by volume.
  13. Manufacturers:
    - a. Dow Chemical Co: [www.dow.com](http://www.dow.com).
    - b. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
    - c. Kingspan Insulation LLC; GreenGuard XPS TYPE IV 25 PSI: [www.trustgreenguard.com](http://www.trustgreenguard.com).
  14. Substitutions: Not permitted.

## 2.3 FIBER BOARD INSULATION MATERIALS

## 2.4 BATT INSULATION MATERIALS

- A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
  2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
  3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
  4. Formaldehyde Content: Zero.
  5. Thickness: As indicated on Construction Documents.
  6. Facing: Unfaced.
  7. Manufacturers:
    - a. CertainTeed Corporation: [www.certainteed.com](http://www.certainteed.com).
    - b. Johns Manville: [www.jm.com](http://www.jm.com).
    - c. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
  8. Substitutions: See Section 016000 - Product Requirements.
- B. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
1. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
  2. Manufacturers:
    - a. Johns Manville; MinWool Sound Attenuation Fire Batts: [www.jm.com](http://www.jm.com).
    - b. Thermafiber, Inc.; SAFB: [www.thermafiber.com](http://www.thermafiber.com).
    - c. ROXUL, Inc; ComfortBatt: [www.roxul.com](http://www.roxul.com).

## 2.5 ACCESSORIES

- A. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.

- B. Tape joints of rigid insulation in accordance with roofing and insulation manufacturers' instructions.
- C. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.
- D. Protection Board for Below Grade Insulation: Cementitious, 1/4 inch thick.
- E. Adhesive: Type recommended by insulation manufacturer for application.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

#### 3.2 BOARD INSTALLATION AT FOUNDATION PERIMETER

- A. Apply adhesive to back of boards:
  - 1. Three continuous beads per board length.
- B. Install boards horizontally on foundation perimeter.
  - 1. Place boards to maximize adhesive contact.
  - 2. Install in running bond pattern.
  - 3. Butt edges and ends tightly to adjacent boards and to protrusions.
- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- D. Immediately following application of board insulation, place protective boards over exposed insulation surfaces.
  - 1. Apply adhesive in five continuous beads per board length.
  - 2. Install boards horizontally from base of foundation to top of insulation.
  - 3. Butt boards tightly, with joints staggered from insulation joints.

#### 3.3 BOARD INSTALLATION AT CAVITY WALLS

- A. Install boards to fit snugly between wall ties.
  - 1. Place membrane surface against adhesive.
  - 2. Place membrane surface facing out, and tape seal board joints.
- B. Install boards horizontally on walls.
  - 1. Place boards to maximize adhesive contact.
  - 2. Install in running bond pattern.
  - 3. Butt edges and ends tightly to adjacent boards and to protrusions.
  - 4. Place impale fastener locking discs.
- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

#### 3.4 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK

- A. Installation of board insulation over low slope roof deck is specified in Section 075200 - Modified Bituminous Membrane Roofing.

#### 3.5 BATT INSTALLATION

- A. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- B. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- C. Coordinate work of this section with requirements for vapor retarder specified in Section 072500.

D. Coordinate work of this section with construction of air barrier seal specified in Section 072500.

3.6 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

072650 – UNDERSLAB VAPOR PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Description of Scope and Intent:
1. CONTRACTOR shall provide all material, labor, and tools required to complete the installation of specified system.
  2. Any omission of reference to items required to complete the full operational and functional system specified in the section does not relieve the CONTRACTOR of the obligation to provide same.
  3. To provide installation of all items, including delivery, dispersing to the proper locations within the building, and affixing in place.
  4. Installation shall be accomplished by workers skilled in their craft that will perform their work in a professional manner and will leave the premises safe, orderly and clean.
  5. Drawings and general provisions of Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.
  6. CONTRACTOR is responsible for coordination of work included in this specification with all other Specification sections related to furnishing of all materials, labor, permits, fees and services necessary for completion of work in this section.
  7. In the event of a conflict between the design Drawings, referenced standards and these Specifications, the more stringent shall govern unless directed otherwise by the ENGINEER. CONTRACTOR shall strictly adhere to OSHA requirements and local codes or those of any regulatory agency or body with jurisdiction.
- B. This Section includes integral pre-applied waterproofing membrane and vapor barrier that bonds to poured concrete for use below slabs on grade, installed in direct contact with concrete.

1.02 SUBMITTALS

- A. Submit MANUFACTURER's product data, installation instructions and membrane samples for approval in accordance with Section 01300.

1.03 REFERENCE STANDARDS

- A. The following standards and publications are applicable to the extent referenced in the text.
- B. American Society for Testing and Materials (ASTM):
1. D 412 – Standard Test Methods for Rubber Properties in Tension
  2. D 903 – Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
  3. D 3767 – Standard Practice for Rubber - Measurements of Dimensions
  4. E 96 – Standard Test Methods for Water Vapor Transmission of Materials
  5. E 154 – Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

6. E 1643 – Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
  7. E 1745 – Plastic Vapor Retarders Used in Contact with Soil or Granular fill under Concrete Slabs
- C. American Concrete Institute (ACI) ACI 302.1R-96 Addendum Vapor Retarder Location: For slabs with vapor-sensitive floor coverings, locate retarder in direct contact with the slab (not beneath a layer of granular fill).

#### 1.04 QUALITY ASSURANCE

- A. Materials: For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.
- B. Schedule Coordination: Schedule work such that membrane will not be left exposed to weather for longer than that recommended by the MANUFACTURER.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 01600. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Basis of Design - Integrally Bonded Vapor Protection: Florprufe™ 120 Membrane by Grace Construction Products, or an equivalent underslab vapor barrier capable of integrally bonding to concrete. The vapor barrier shall be a 0.5 mm (0.021 inch) nominal thickness composite sheet membrane comprising 0.4 mm (0.016 inch) of polyolefin film, and layers of specially formulated synthetic adhesive layers. The membrane shall form an integral and permanent bond to poured concrete to prevent vapor migration at the interface of the membrane and structural concrete.

- B. Provide membrane with the following physical properties:

Property	Typical Value	Test Method
Thickness (nominal)	0.5 mm (0.021 inch)	ASTM D3767 Method A
Water Vapor Permeance	0.03 perms	ASTM E96 Method B *
Tensile Strength	68 lb./inch	ASTM E154 *
Elongation	300%	ASTM D412
Puncture Resistance	3300 grams	ASTM D1709 *
Peel Adhesion to Concrete	>4 lb./inch	ASTM D903

\* ASTM E 1745 Requirements.



### PART 3 - EXECUTION

#### 3.01 EXECUTION

- A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the CONTRACTOR, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

#### 3.02 INSTALLATION

- A. Earth and stone substrates shall be well compacted to produce an even, solid substrate. Remove loose aggregate or sharp protrusions. Concrete substrates shall be smooth or broom finished and monolithic. Remove standing water prior to membrane applications.
- B. Place all foundation and slab insulation around slab/foundation perimeter before installation of membrane. Join the entire perimeter edges of the vapor barrier with the waterproof barrier sealing the foundation walls.
- C. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643-98, including but not limited to, the following:
  - 1. Apply membrane with the HDPE film facing the prepared substrate. Remove the release liner during application.
  - 2. Apply succeeding sheets by overlapping the previous sheet 50-mm (2-inch.) along the marked lap line. End Laps should be staggered to avoid a build up of layers.
    - a. Mechanical Fastening – To prevent the membrane from moving and gaps opening, the laps should be fastened together at 39 in maximum centers. Fix through the center of the lap area using 0.5-inch long washer-head self-tapping galvanized screws.
    - b. Taped Lap – Use manufacturer's recommended tape to secure and seal the overlaps. Overband the lap with 4-inch wide tape using the lap line for alignment. Remove plastic release liner to ensure bond to concrete.
  - 3. Mix and apply liquid detailing compound to seal around penetrations such as drainage pipes, etc.

#### 3.03 CONCRETE PLACEMENT

- A. Place concrete within 30 days. Inspect membrane and repair any damage with patches of tape. Ensure all liner is removed from membrane and tape before concrete placement.

#### 3.04 SCHEDULE

- A. Provide underslab vapor barrier under all building slabs on grade, including the re-pump station building and the sodium hypochlorite structure. Perimeter of underslab vapor barriers shall join the sealant of the foundation.

END OF SECTION 072650

SECTION 07 27 26 FLUID-APPLIED MEMBRANE AIR BARRIERS, VAPOR-PERMEABLE

**PART 1 GENERAL**

1.1 SECTION INCLUDES

- A. Fluid-applied, vapor-permeable, membrane air barrier: Materials that form a system to stop passage of air & moisture vapor through exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls.

1.2 RELATED SECTIONS

- A. Section 014000 Quality Requirements; coordination with owners' independent testing and inspection agency
- B. Section 014339 Mock-Ups; exterior wall mock-ups
- C. Section 015000 Temporary Facilities and Controls; Work Schedule requirements to prevent weather or sunlight exposure beyond the manufacturer limits; project requirements to protect installed material prior to and during the enclosure work is completed.
- D. Section 03300 Cast-In-Place Concrete; requirements for smooth and protrusion free surface
- E. Section 042200 Reinforced Unit Masonry; Requirements for masonry joints are flush and filled with mortar, removal of excess mortar on brick ties.
- F. Section 04113 Brick Veneer Masonry; Requirements for masonry joints are flush and filled with mortar, removal of excess mortar on brick ties.
- G. Section Cast Stone Masonry
- H. Section 061600 Sheathing for air barrier substrates and joint treatment
- I. Section 075000 Roofing Membrane; roof assembly and air barriers interface coordination and sequencing
- J. Section 092900 Gypsum Board
- K. Exterior wall claddings

1.3 REFERENCE STANDARDS

- A. AAMA- American Architectural Manufacturers Association
  - 1. AAMA 711 Voluntary Specification for Self-Adhering Flashing Products Used for the Installation of Exterior Wall Fenestration Products.
  - 2. AAMA 714 Voluntary Specification for Liquid Applied Flashing Used to Create a Water Resistive Seal Around Exterior Wall Openings in Buildings
- B. ASTM- American Society for testing and Material Standards [www.astm.org](http://www.astm.org)
  - 1. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
  - 2. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
  - 3. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials
  - 4. ASTM E2178 Standard Test Method for Air Permeance of Building Material
  - 5. ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier

Assemblies

6. ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
- C. Building Codes and Standards
  1. 2015 ICC-ES AC 212 CIC ES Water-resistive Coatings Used as Water-resistive Barriers over Exterior Sheathing
  2. 2021, 2018, 2015, and 2009 IBC International Building Code
  3. 2021, 2018, 2015, 2012, and 2009 IRC International Residential Code
  4. 2021, 2018, 2015, and 2009 IECC International Energy Conservation Code
  5. US Environmental Protection Agency's AIM VOC regulations
- D. GA - Gypsum Association
  1. GA-253 Application of Gypsum Sheathing
- E. NFPA - National Fire Protection Association
  1. NFPA 285 Standard Fire Test Method for Evaluating of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components
- F. US Department of Commerce (DOC)
  1. DOC PS 1 - Structural Plywood
  2. DOC PS 2 - Performance Standard for Wood-Based Structural Panels

#### 1.4 SUBMITTALS

- A. Submittals: Submit in accordance with Division 1 requirements.
- B. Product Data: Submit manufacturer's product data including accessory material types, composition, descriptions, and properties.
- C. Installation instructions and substrate preparation recommendations.
- D. Shop Drawings of Mock-Up; Shop drawings of proposed mock-up(s) including plans, elevations, details, and air barrier transitions.
- E. Shop Drawings: Submit shop drawings indicating locations and extent of fluid-applied air barrier membrane system, including details of typical conditions, special joint conditions, intersections with other building envelope systems and materials; counter flashings and details showing bridging of envelope at substrate changes, details of sealing penetrations, and detailed flashing around windows and doors
- F. Sample warranty: Submit a sample warranty identifying the terms and conditions of the warranty as herein specified.
- G. VOC Regulations: Provide products that meet volatile organic emission standards.
- H. Evaluation reports: Accredited laboratory testing for materials

#### 1.5 WARRANTY

- A. Provide manufacturer's standard warranty for the fluid-applied air barrier membrane to be free of manufacturing defects that make it unsuitable for its intended use. Warranty period shall be Ten (10) years from the date of installation of the product.

- B. Provide manufacturer's standard warranty for use as a drainage plane when the cladding systems are properly designed and installed, with a warranty period of 10 years from the date of installation of the product or.

#### 1.6 QUALITY ASSURANCE- PRECONSTRUCTION CONFERENCE

- A. Conduct preconstruction conference onsite at project
- B. Review air barrier products and installation requirements
- C. Mock-up construction and expectations
- D. Testing and inspection requirements
- E. Sequencing and coordination of air barrier work with other materials and sections
- F. Compatibility of materials that will interface with the primary fluid-applied membrane material and accessories.

#### 1.6 QUALITY ASSURANCE- MATERIAL

- A. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E 2357.

#### 1.7 QUALITY ASSURANCE - MOCK UP

- A. Provide air barrier for mock-up for each backup wall construction as specified in [Section 014339 Mock-Ups.] [Section\_\_\_\_\_].
- B. Include examples of surface preparation, detailing of penetration, crack and joint treatment, air barrier application, termination conditions, flashing, transitions to roof and foundation materials, and adjacent materials.

#### 1.8 QUALITY ASSURANCE – REGULATORY COMPLIANCE

- A. Comply with US Environmental Protection Agency's AIM VOC regulations
- B. Comply with 2015 ICC-ES AC 212 CIC ES Water-resistive Coatings Used as Water-resistive Barriers over Exterior Sheathing
- C. Comply with 2018 and 2021 IRC requirements for continuous air barrier
- D. Comply with 2018 and 2021 air barrier requirements of the IBC and IECC

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and accept materials to the Project site in original packaging with seals unbroken and label with Manufacturer's name.
- B. Protect materials from damage, excessive temperatures, and construction traffic.
- C. Store materials in a cool and dry area.
- D. Handle materials in accordance with the manufacturer's recommendation,

#### 1.10 FIELD CONDITIONS

- A. Temperature: Install the air barrier materials within the range of ambient and substrate temperature recommended by the material manufacturer.

- B. Field Conditions: Do not install the air barrier when the temperature of the substrate surface

- or air temperature are below or above the manufacturer's recommendations.
- C. Sequencing: Coordinate installation of the roof assembly to ensure the roof assembly is sufficiently installed to prevent accumulation of water in the interior of the building. Schedule other work requiring interface with the air barrier to ensure proper sequencing.
  - D. Compatibility. Do not allow air barrier materials to come in contact with chemically incompatible materials.
  - E. Ultra-violet exposure. Do not expose air barrier materials to sunlight longer than as recommended by the material manufacturer.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Designs: Provide air barrier products manufactured by Georgia-Pacific Gypsum LLC 1-800-225-6119; email: [techservices@gapac.com](mailto:techservices@gapac.com) [www.buildgp.com](http://www.buildgp.com) or comparable products approved by the Architect in agreement with Division 1 General Requirements.
- B. Source Limitations: Obtain the primary air-barrier materials from a single source manufacturer.

### 2.2 MATERIALS

- A. Primary Air Barrier Material: DensDefy™ Liquid Barrier - single component Silyl-Terminated Polymer (STP) air and water-resistive barrier applied by roller or with spray equipment applied at a minimum of 14 wet mils
- B. Air Barrier Accessory Materials
  - 1. Fluid applied flashing for joints, inside and outside corners, material transitions, board to board seams, wall to slab, and penetrations
    - a. DensDefy™ Liquid Flashing - a waterproofing and detailing compound made with STP Technology
  - 2. Self-Adhering transition membrane for flashing of rough openings, material transitions, and wall to slab
    - a. DensDefy™ Transition Membrane - 25-mil composite impermeable membrane that is comprised of 16 mils of butyl adhesive and 9 mils of HDPP facer.

### 2.3 PERFORMANCE

- A. Fluid-Applied Membrane Air Barrier Performance
  - 1. Air Performance ASTM E2178; Air Permeance ASTM E2178:  $\leq 0.004$  cfm/sq ft of surface area at 1.57-lbf/sq. ft ( $\leq 0.02$  L/s x sq. m of surface area at 75-Pa)
  - 2. Vapor Performance ASTM E96; Minimum of 14 perms
  - 3. Tensile Strength of Sandwich Construction ASTM C297: pull strength meeting or exceeding 15 psi.
  - 4. Elongation: ASTM D412 >400% at break
  - 5. Surface Burning Characteristics: ASTM E84; Class A; a flame spread of no greater than 25; smoke development of 10
  - 6. VOC content <30 g/L.

7. Pass Hydrostatic Pressure Test (3-stage) per ICCES AC212
8. Exposed to normal weathering conditions for up to 12 months
- B. Fluid Applied Flashing Performance
  1. Comply with AAMA 714-19: Voluntary Specification for Liquid-Applied Flashing Used to Create a Water-Resistive Seal Around Exterior Walls in Openings in Buildings
- C. Self-Adhering Transition Membrane Performance
  1. Comply with AAMA 711: Voluntary Specifications for Self-Adhering Flashing Used for Installation of Exterior Wall Fenestration Products.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Before applying the air barrier material ensure the following conditions are met.
  1. Verify that the surfaces conditions are suitable prior to commencing installation
  2. Concrete: Provide concrete in conformance with applicable building codes
  3. Concrete Masonry Units (CMU) are in conformance with the applicable building code and masonry joints are flush and filled.
  4. Masonry surfaces have cured for the recommended time period by the membrane manufacturer and are free from release and curing agents, excess mortar, or other contaminates.
  5. Gypsum Sheathing is installed in accordance with GA-253 and compliance with ASTM C1177
  6. Substrates are smooth without large voids or sharp protrusions.
  7. Structural Plywood meets the established requirements of DOC PS 1 Structural Plywood
  8. Oriented Strand Board (OSB) meets the establishes requirements of DOC PS 2 Performance Standard for Wood-Based Structural Panels
- B. Test for capillary moisture by plastic sheet method according to ASTM D4263
- C. Verify sealants are compatible with air barrier membrane used.
- D. Ensure field conditions are met as outlined in Part 1 – General Requirements.
- E. Proceed with air barrier installation only after unsatisfactory conditions have been corrected.

### **3.2 SURFACE PREPARATION**

- A. Clean, prepare, and treat substrate in accordance with the air barrier manufacturers written instructions
- B. Apply treatment to board-to-board seams in sheathing and surface cracks in masonry substrates per the air barrier manufacturers written instructions.
- C. Remove all bond inhibiting agents, such as dust, mud, oils, curing compounds or any other substances that might prevent placement and bonding of membrane
- D. Fill voids with a substrate patching material
- E. Mask or cover adjacent areas to protect from over-spray

### 3.3 GENERAL INSTALLATION AIR BARRIER MEMBRANE

- A. Install fluid-applied air barrier membrane and system accessories to achieve a monolithic, void-free, continuous building envelope.
- B. Install fluid-applied air barrier and system accessories in accordance with manufacturer's written instructions.
- C. Install fluid-applied membrane using equipment and methods in the air barrier written instructions to achieve required free-film thickness by the manufacturer.

### 3.4 GENERAL INSTALLATION OF ACCESSORY MATERIALS

- A. Install accessory materials according to the Air Barrier written instruction to seal and connect air barrier material to adjacent material
- B. Transitions: Seal, flash, and connect air barrier material continuously to below-grade structures, roofing membrane, floor-to-floor conditions, window and glazing systems including curtain wall and storefront assemblies, door system, and other exterior wall openings.
  - 1. Self-adhered transition membrane at transitions and rough openings: By the end of each workday, flash all edges of the applied self-adhered membrane with a manufacturer approved liquid flashing. Overlap self-adhere transitional membrane using a shingle lap method and roll-out installed membrane to ensure a secure adhesion to the substrate
- C. Penetrations: Seal around all exterior wall penetrations with liquid flashing or manufacture approved sealant to prevent air and water infiltration. For round or square pipe/duct penetrations use specified fluid applied flashing, refer to the air barrier written instructions for proper sealing.

### 3.5 FIELD QUALITY CONTROL

- A. Do not cover installed fluid-applied air barrier membrane assembly until required inspections have been completed and installation has been accepted.
- B. Where applicable, allow for owner's inspection and air barrier testing and reporting.
- C. If the inspections or testing reveal any deficient application, remediate deficient work promptly

### 3.6 PROTECTION

- A. Protect air barrier membrane assembly from damage during installation and during the construction period.
- B. Coordinate to protect air barrier membrane from UV light exposure for a period greater than the acceptable by the air barrier membrane manufacture.
- C. Use cleaning agents and procedures recommended by the manufacturer of affected construction to remove spills, stains, and overspray prior to curing.

END OF SECTION

## The SECTION 074113 - STANDING-SEAM METAL ROOF

### PANELS PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes standing-seam metal roof panels.
- B. Roof insulation.

#### 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
  - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
  - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
  - 5. Review structural loading limitations of deck during and after roofing.
  - 6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
  - 7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
  - 8. Review temporary protection requirements for metal panel systems during and after installation.
  - 9. Review procedures for repair of metal panels damaged after installation.
  - 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.



- 2.
- B. Shop Drawings:
  1. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
  2. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
  3. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
  1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
  1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Material Certificates: For thermal insulation, from manufacturer.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or

deformed. Package metal panels for protection during transportation and handling.

- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.
- E. Protect foam-plastic insulation as follows:
  - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
  - 2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
  - 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

#### 1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

#### 1.9 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including rupturing, cracking, or puncturing.
    - b. Deterioration of metals and other materials beyond normal weathering.
  - 2. Special warranty includes membrane roofing, base flashings, roof insulation, cover

- boards, and other components of roofing system.
- 3. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
  - 1. Wind Loads: As indicated on Structural Drawings.
  - 2. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 or ASTM E 283 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 or ASTM E 331 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
  - 1. Uplift Rating: UL 90.
- F. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-
  2. Hail Resistance: MH.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.2 STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips inside laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
- B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
1. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.
    - a. Nominal Thickness: 0.028 inch (0.71 mm).
    - b. Exterior Finish: Two-coat fluoropolymer.
    - c. Color: Kynar 500 - Zinc Gray (MP2.2)
  2. Clips: Two-piece floating to accommodate thermal movement.
    - a. Material: 0.028-inch- (0.71-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
  3. Joint Type: Single folded.
  4. Panel Coverage: 16 inches (406 mm).
  5. Panel Height: 2.0 inches (51 mm).

## 2.3 ROOF INSULATION

- A. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1 or 2 felt or glass-fiber mat, Grade 3, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.

- 1. R-Value: 30.

## 2.4 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer and cover board to insulation as follows:

- 1. Full-spread spray-applied, low-rise, two-component urethane adhesive.

- D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) thick, factory primed.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Georgia-Pacific Corporation; Dens Deck Prime.

## 2.5 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

- 1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
  - 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
  - 3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Carlisle Residential, a division of Carlisle Construction Materials; WIP 300HT.
    - b. Grace Construction Products, a unit of W. R. Grace & Co.; Grace Ice and Water Shield HT.
    - c. Owens Corning; WeatherLock Metal High Temperature Underlayment.

## 2.6 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Sub-framing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
  - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
  - 2. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (914 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.
- E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts as indicated in Section 090690 Color Schedule.
- F. Roof Curbs: Fabricated from same material as roof panels, 0.048-inch (1.2-mm) nominal thickness; with bottom of skirt profiled to match roof panel profiles and with welded top box and integral full-length cricket. Fabricate curb sub-framing of 0.060-inch- (1.52-mm-) nominal thickness, angle-, C-, or Z-shaped steel sheet. Fabricate curb and sub-framing to withstand indicated loads of size and height indicated. Finish roof curbs to match metal roof panels.
  - 1. Insulate roof curb with 1-inch- (25-mm-) thick, rigid insulation.
- G. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- H. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
  - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound

sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

## 2.7 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
  1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
  3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
  4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
  5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
  6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

## 2.8 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
  - 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- B. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

### 3.3 THERMAL INSULATION INSTALLATION



- A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
- D. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - 1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- E. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
  - 1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
  - 2. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- F. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and adhere to insulation.
  - 1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

### 3.4 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
  - 1. Apply over the entire roof surface.
- B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

### 3.5 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Shim or otherwise plumb substrates receiving metal panels.
  - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
  - 3. Install screw fasteners in predrilled holes.
  - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 5. Install flashing and trim as metal panel work proceeds.
  - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
  - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
  - 1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
  - 1. Install clips to supports with self-tapping fasteners.
  - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
  - 3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
  - 4. Watertight Installation:
    - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
    - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
    - c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight

mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
  2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.
1. Provide elbows at base of downspouts to direct water away from building.
  2. Connect downspouts to underground drainage system indicated.
- J. Roof Curbs: Install flashing around bases where they meet metal roof panels.
- K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

### 3.6 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

### 3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

### 3.8 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113

## SECTION 074217 - SOFFIT PANELS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes metal soffit panels.

#### 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Sustainable Design Submittals:
  - 1. Product Data: For recycled content, indicating postconsumer and pre-consumer recycled content and cost.
- C. Shop Drawings:
  - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
  - 2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
  - 1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For special warranties.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:

- a. Structural failures including rupturing, cracking, or puncturing.
  - b. Deterioration of metals and other materials beyond normal weathering.
2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
1. Wind Loads: As indicated on Structural Drawings.
  2. Other Design Loads: As indicated on Structural Drawings.
  3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

### 2.2 METAL SOFFIT PANELS

- A. General: Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

### 2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Sub-framing and Furring: ASTM C 645, cold-formed, metallic-coated steel

sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
  - 1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
  - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
  - 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
  - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

## 2.4 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide



a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  2. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
  3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
  4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

## 2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting

performance of the Work.

1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
  - a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.
  1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

### 3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  1. Shim or otherwise plumb substrates receiving metal panels.
  2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
  3. Install screw fasteners in predrilled holes.
  4. Locate and space fastenings in uniform vertical and horizontal alignment.
  5. Install flashing and trim as metal panel work proceeds.
  6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
  1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
  - 1. Apply panels and associated items true to line for neat and weathertight enclosure.
  - 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
  - 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
  - 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
- E. Watertight Installation:
  - 1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
  - 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
  - 3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
  - 1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
  - 1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
  - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074217

SECTION 075216 - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS  
MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Furnish labor, materials, tools and other equipment, and services necessary to provide a styrene-butadiene-styrene (SBS) modified bituminous membrane roofing assembly system to the full extent of the Contract Documents, including all components and accessory items as required for complete installation. Following are items of Work normally associated with this Section.
  - 1. Recovery Boards
  - 2. SBS-Modified Bituminous Roof Membrane Application
  - 3. Roof Flashing Application
  - 4. Incorporation of Sheet Metal Flashing Components and Roofing Accessories into the Roof System
  - 5. Walkway Pads
  - 6. Preparation of Roofing Substrate to receive Roofing Assembly System.
- B. Refer to Drawings and Part 2 of this Section for specific details and requirements.

1.3 RELATED SECTIONS

- A. Following are related Sections that contain additional Contractor requirements. Not all of these listed Sections may apply to this Project nor are they being represented as being all inclusive of every related Section possibly associated with this Section.
  - 1. Division 01 Section "Project Management and Coordination" for pre-installation conference.
  - 2. Division 03 Sections "Cast-In-Place Concrete" and "Miscellaneous Cast-In-Place Concrete" for compressive strength, curing methods, and finishes for roof decks.
  - 3. Division 03 Section "Lightweight Insulating Concrete" for fire-test-response characteristics, FMG listings, embedded rigid board insulation, compressive strength, and finishes for roof insulation fill.
  - 4. Division 05 Section "Steel Decking" for fire-test-response characteristics, FMG listings, fastenings, acoustical roof deck, vented form deck, and steel roof deck.
  - 5. Division 06 Section "Rough Carpentry" for wood blocking, curbs, cants, and nailers and for wood-based, structural-use roof decking.
  - 6. Division 07 Section "Sheet Metal Flashing and Trim" for shop- or field-fabricated sheet metal copings, fasciae, gravel stops, flashing receivers, equipment support flashings, roof penetration flashings, and counter-flashings.

7. Division 07 Section “Roof Specialties” for proprietary manufactured metal copings, fasciae, gravel stops, reglets, and counter-flashings.
8. Division 07 Section “Roof Accessories” for proprietary manufactured metal roof curbs, equipment supports, and heat and smoke vents.
9. Division 07 Section “Joint Sealants” for joint sealants, joint fillers, and joint preparation.
10. Division 22 Section “Storm Drainage Piping Specialties” for roof drains.

#### 1.4 REFERENCE STANDARDS

- A. Following are reference standards normally associated with this Section. All of these Standards may not apply to this Project nor are they being represented as being all inclusive of every reference standard associated with this Section. Refer to Division 00 Section “Supplementary Conditions,” Article 1, concerning version of Standards referenced.

1. American Society For Testing Materials (ASTM) International:
  - a. ASTM C 36: Specification for Gypsum Wallboard
  - b. ASTM C 67: Test Methods of Sampling and Testing Brick and Structural Clay Tile
  - c. ASTM C 140: Test Methods of Sampling and Testing Concrete Masonry Units
  - d. ASTM C 208: Specification for Cellulosic Fiber Insulating Board
  - e. ASTM C 552: Specification for Cellular Glass Thermal Insulation
  - f. ASTM C 578: Specification for Rigid, Cellular Polystyrene Thermal Insulation
  - g. ASTM C 726: Specification for Mineral Fiber Roof Insulation Board
  - h. ASTM C 728: Specification for Perlite Thermal Insulation Board
  - i. ASTM C 1177/C 1177M: Specification for Glass Mat Gypsum Substrate for Use as Sheathing
  - j. ASTM C 1289: Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
  - k. ASTM D 41: Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
  - l. ASTM D 312: Specification for Asphalt Used in Roofing
  - m. ASTM D 448: Classification for Sizes of Aggregate for Road and Bridge Construction
  - n. ASTM D 1079: Terminology Relating to Roofing, Waterproofing, and Bituminous Materials
  - o. ASTM D 1227: Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
  - p. ASTM D 1668: Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
  - q. ASTM D 1863: Specification for Mineral Aggregate Used on Built-up Roofs
  - r. ASTM D 2178: Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
  - s. ASTM D 2626: Specification for Asphalt-Saturated and -Coated Organic Felt Base Sheet Used in Roofing
  - t. ASTM D 2824: Specification for Aluminum-Pigmented Asphalt Roof Coatings, Non-Fibered, Asbestos Fibered, and Fibered without Asbestos
  - u. ASTM D 3617: Practice Sampling and Analysis of New Built-up Roof Membranes
  - v. ASTM D 4263: Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

- w. ASTM D 4397: Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
- x. ASTM D 4586: Specification for Asphalt Roof Cement, Asbestos-Free
- y. ASTM D 4601: Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
- z. ASTM D 4897: Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
- aa. ASTM D 6083: Specification for Liquid Applied Acrylic Coating Used in Roofing
- bb. ASTM D 6164: Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Material Using Polyester Reinforcements
- cc. ASTM D 6298: Specification for Fiberglass Reinforced Styrene-Butadiene- Styrene (SBS) Modified Bituminous Sheets with a Factory Applied Metal Surface
- dd. ASTM E 108: Test Methods for Fire Tests of Roof Coverings
- ee. ASTM E 119: Test Method for Fire Tests of Building Construction and Materials
- ff. ASTM E 548: Guide for General Criteria Used for Evaluating Laboratory Competence

B. American Society of Civil Engineers:

- 1. ASCE 7-10: Minimum Design Loads for Building and Other Structures.
  - a. The manufacture will meet the ASCE 7-10 design criteria. This format will require the uplift calculations for the roof system to be provided, stamped and certified by a Licensed Engineer in the State of Alabama.

C. Asphalt Roofing Manufacturers Association/National Roofing Contractors Association:

- 1. Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing.

D. International Building Code:

- 1. Addition that complies to the local building authority.

E. References Factory Mutual Global: This project is not an FM Insured Building, therefore, FM approvals need only to be used as a guide to meet the intent of a FM 1- 185 approval for this Specification.

- 1. Meet the intent of FMG 4450: Approval Standard for class 1 Insulated Steel Deck Roofs
- 2. Meet the intent of FMG 4470: Approval Standard Class 1 Roof Covers
- 3. Approval Guide

F. National Roofing Contractors Association

- 1. The NRCA Roofing and Waterproofing Manual

G. Underwriters Laboratories

- 1. UL Roof Materials and Systems Directory
- 2. UL Fire Resistance Directory

H. U.S. Department of Commerce, National Institute of Standards and Technology:

- 1. DOC PS 2: Performance Standard for Wood-Based Structural-Use Panels

- I. Sheet Metal Terminology and Techniques: SMACNA Architectural Sheet Metal Manual
- J. This specification shall be supplemented by any applicable federal, state and local building codes, guidelines, regulations, and standards adopted in the immediate geographic area of the Project; insurance rating organizations; including all other Authorities Having Jurisdiction.

#### 1.5 DEFINITIONS

- A. A listing of definitions normally associated with this Section. All of the following definitions may not apply to this Project.
  - 1. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

#### 1.6 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7, or in compliance with local building code requirements if they are more stringent than ASCE/SEI 7. Coordinate minimum code requirements with Structural Drawings.
- D. Agency Approvals: The proposed roof system shall conform to the following requirements. No other testing agency approvals will be accepted.
  - 1. International Building Code as referenced by the local building officials having jurisdiction over the project.
  - 2. FM Approvals Listing: The FM approvals can be used to meet the intent of the roofing membrane, base flashings and component materials as they apply to FM 4450 and FM 4470, as part of the roofing membrane system.
    - a. Fire/Windstorm Classification: The roof configuration, including fastening of base sheet, insulation, etc., shall meet the intent of a FM approval for minimum Class 1A-185 wind uplift construction.
    - b. Hail Resistance: Class 1 SH (Severe Hail - For areas having three or more hailstorms annually) exposure.

#### 1.7 SUBMITTALS:



- A. Certification of Compliance: Submit all information necessary to indicate full compliance to all requirements specified herein, otherwise, submittal will be returned marked 'Rejected.'
- B. Submit in accordance with the requirements specified in Division 01 Section "Submittal Procedures."
- C. Action Submittals:
  - 1. Refer to Division 01 Section "Product Requirements" in its entirety with particular attention to "Submittals" Article 1.6.
  - 2. Product Schedule: For SBS roofing system. Descriptive list of all materials proposed for use as described in Division 01 Section "Submittal Procedures." Use same designations indicated on Drawings.
  - 3. Product Data for all materials proposed for use:
    - a. Manufacturer's current technical product data and specifications for each type of product indicated, describing material physical and mechanical properties for each sheet including weights and thicknesses; low temperature flexibility; peak load, ultimate elongation, dimensional stability; high temperature stability; and granule coverage.
    - b. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.
  - 4. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.
    - a. Base flashings, cants, and membrane terminations
    - b. Tapered insulation, including slopes
    - c. Crickets, saddles, and tapered edge strips, including slopes
    - d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations
  - 5. Samples for Verification: For the following products:
    - a. Two 8-inch by 8-inch squares of each of the following sheet roofing materials:
      - 1) Cover board
      - 2) Base-ply sheet
      - 3) Flashing backer sheet
      - 4) Membrane cap sheet
      - 5) Flashing sheet
      - 6) Roof insulation
      - 7) Walkway pad or rolls
    - b. Granule Surfacing Material: Refer to the Membrane Cap Sheet for Granule surfacing material.
    - c. Fasteners: If mechanical fasteners are required, supply (6) of each type, length and finish.
- D. Maintenance Data: Refer to Johns Manville's latest published documents on [www.specJM.com](http://www.specJM.com).

- E. Guarantees: Special guarantees specified in this Section.
- F. Informational Submittals:
  - 1. Refer to Division 01 Section “Quality Requirements” in its entirety with particular attention to “Submittals” Article 1.9.
  - 2. Qualification Data: For qualified Installer, manufacturer, and testing agency.
  - 3. Manufacturer Certificates: Signed by roofing manufacturer certifying the following:
    - a. Roofing system complies with requirements specified in “Performance Requirements” Article.
  - 4. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
  - 5. Research/Evaluation Reports: For components of membrane roofing system, from the applicable model code organization.
  - 6. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.
  - 7. Maintenance Data: Manufacturer's printed recommendations for proper maintenance of the specified roof system including inspection frequencies, penetration addition policies, temporary repairs, and leak call procedures, to be included also in maintenance manuals.
  - 8. Warranties: Sample copy of Manufacturer’s special warranties specified in this Section. Refer to “Warranty” Article below.
  - 9. Installer Certification: Certificate signed by Manufacturer, certifying that installer is approved, authorized, and/or certified to install roofing system. If letter is provided by proposed primary roofing system manufacturer, then letter must also state that the installer is “eligible to receive manufacturer's warranty”. Refer to “Installer Qualifications” under Article “Quality Assurance.”
  - 10. Torch Welding Certificate: Signifying the welder performing the torch application of roof system materials (flashing) is a Certified Roofing Torch Applicator per NRCA (National Roofing Contractor Association).

#### 1.8 QUALITY ASSURANCE

- A. Refer to Division 01 Section “Quality Requirements” in its entirety with particular attention to “Quality Assurance” Article 1.13 and “Quality Control” Article 1.14, and Division 01 Section Product Requirements” in its entirety with particular attention to “Quality Assurance” Article 1.7.
- B. Additional Manufacturer Qualifications: A qualified manufacturer that has been successfully producing the specified types of primary membrane roofing products for not less than 10 years and maintaining a consistent composition for a minimum for 5 years. Qualified manufacturer shall be UL listed and must obtain International Building Code approvals for the specified roofing system used on this project.
- C. Manufacturer Requirements: The primary roofing manufacturer shall provide direct- trained company personnel, to attend necessary job meetings, perform periodic inspections as necessary, and conduct a final inspection upon successful completion of the project.
- D. Additional Installer Qualifications:

1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
    - a. Torch Safety: Torch application of roof system materials (flashing), shall be performed only by a certified roofing torch applicator. Crew members handling torches shall be trained by an Authorized Certified Roofing Torch Applicator (CERTA) Trainer, be certified according to CERTA torch safety guidelines as published by the National Roofing Contractors Association (NRCA), and follow torch safety practices as required by the contractor's insurance carrier. Designate one person on each crew to perform a daily fire watch. The designated crew member shall watch for fires or smoldering materials on all areas during roof construction activity, and for the minimum period required by CERTA guidelines after roofing material application has been suspended for the day.
  2. Roofing system Installer must comply with the International Building Code as referenced by the local building officials having jurisdiction over the project.
  3. Provide a list of the last three project installations of comparable extent as this Project, including name and location of Project, specifying Owner Representative's/project manager's name and phone number, start and completion dates, and value of the Work.
- E. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test- response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
1. Fire-Resistance Ratings: ASTM E 119, for fire-resistance-rated roof assemblies of which roofing system is a part.
- F. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- G. Test Reports:
1. Roof drain and leader test or submit plumber's verification.
  2. Core cut (if requested).
- H. Source Limitations: Obtain all components from the single source roofing system manufacturer guaranteeing the roofing system. All products used in the system shall be labeled by the single source roofing manufacturer issuing the guarantee.
- I. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- J. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site. Review methods and procedures related to roof deck and roofing system including, but not limited to, the following:
1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck

- Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
  3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  4. Review deck substrate requirements for conditions and finishes, including flatness and fastening/adhering.
  5. Review structural loading limitations of roof deck during and after roofing.
  6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing assembly system.
  7. Review roof assembly system in its entirety including vapor/air retarders to avoid the potential of vapor condensation on the bottom of roof decking/roofing substrate.
  8. Review governing regulations and requirements for insurance and certificates if applicable.
  9. Review temporary protection requirements for roofing system during and after installation.
  10. Review roof observation and repair procedures after roofing installation.
- K. Pre-Installation Roofing Conference: Conduct conference at Project site. Comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:
1. Meet with Owner, Owner's Corporate Representative, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
  3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening/adhering.
  5. Review structural loading limitations of roof deck during and after roofing.
  6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
  7. Review roof assembly system in its entirety including vapor/air retarders to avoid the potential of vapor condensation on the bottom of roof decking/roofing substrate.
  8. Review governing regulations and requirements for insurance and certificates if applicable.
  9. Review temporary protection requirements for roofing system during and after installation.
  10. Review roof observation and repair procedures after roofing installation.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Refer to Division 01 Section "Product Requirements" in its entirety with particular attention to "Product Delivery, Storage, and Handling" Article 1.8.
  - B. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

- C. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- D. Protect roofing materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.
  - 1. Store roofing materials on a clean, flat, and dry surface.
  - 2. All material stored on the roof overnight shall be stored on pallets.
  - 3. Rolls of roofing must be stored on ends.
  - 4. Store materials such as solvents, adhesives, and asphalt cutback products away from open flames, sparks, or excessive heat.
  - 5. Cover all material using a breathable cover such as a canvas. Polyethylene or other non-breathable plastic coverings are not acceptable.
  - 6. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- E. Handle all materials in such a manner as to preclude damage and contamination with moisture or foreign matter. Handle rolled goods to prevent damage to edges or ends.
- F. Damaged Material: Any materials that are found to be damaged or stored in any manner other than stated above will be automatically rejected, removed, and replaced at the Contractor's expense.
- G. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of roof deck.

#### 1.10 PROJECT / SITE CONDITIONS

- A. Environmental Requirements
  - 1. Precipitation: Do not apply roofing materials during precipitation or in the event there is a probability of precipitation during application.
    - a. Take adequate precautions to ensure that materials, applied roofing, and building interiors are protected from possible moisture damage or contamination.
  - 2. Temperature Restrictions (Cold Adhesive):
    - a. Optimal temperature of adhesive at point of application shall be 70°F.
    - b. When ambient temperatures are below 50°F, keep adhesive and roll goods warm prior to use.
    - c. Roll or broom the sheets to ensure contact with the underlying adhesive.
    - d. Suspend application in situations where the adhesive cannot be kept at temperatures allowing for even distribution.
- B. Protection Requirements

1. Membrane Protection: Provide protection against staining and mechanical damage for newly applied roofing and adjacent surfaces throughout this project.

#### 1.11 WARRANTY

- A. Refer to Division 01 Section "Product Requirements" in its entirety with particular attention to "Product Warranties" Article 1.9.
- B. Warranties: General and special warranties specified in this Article will not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and are in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
  1. Pass-through warranties provided by subcontractors to manufacturer are not acceptable.
- C. A Single Source Warranty: Manufacturer's job-specific total warranty systems, without monetary limitation, in which manufacturer agrees to repair or replace components (including removal and disposal of components) of roof assembly system that fail in materials or workmanship/installation within specified warranty period.
  1. Single-Source special guarantee includes roof insulation, roofing plies, base flashings, liquid applied flashing, roofing membrane accessories, fasteners, walkway products, manufacturer's expansion joints, and other single-source components of roofing system marketed by the manufacturer.
  2. Guarantee Period: 20 years from date of Substantial Completion
- D. Additional Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roof assembly such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period.
  1. Guarantee Period Five Years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 PRODUCT SELECTION

- A. In other Articles within Part 2 of this Section where titles such as 'Product,' 'Products,' 'Available Products,' 'Manufacturer,' 'Manufacturers,' 'Available Manufacturers,' 'Product Options,' 'Basis-of-Design,' etc. introduce lists, refer to Division 01 Section "Product Requirements" in its entirety with particular attention to "Product Selection Procedures" Article 2.1.

#### 2.2 GENERAL

- A. Provide products which are recommended by the Manufacturer to be fully compatible with indicated substrates or provide separation materials as required to eliminate contact between incompatible materials. All new materials shall be manufactured in the U.S.A.

- B. These Specifications are to be considered MINIMUM STANDARDS. If a listed manufacturer wishes to add value to his specification, it will be acceptable. However, if a manufacturer wishes to reduce the quantity/quality of his published specification, it will be rejected.

## 2.3 SBS-MODIFIED ASPHALT-SHEET MATERIALS

### A. SBS-Modified Bituminous Membrane Roofing:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Johns Manville, 717 17<sup>th</sup> Street Denver, CO.

### B. Granule Surfaced System (Factory Applied Granule Coating):

- 1. Roofing Membrane Sheet: ASTM D 6164, Grade S, Type I, polyester-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified. Basis of Design: [DynaWeld 180S](#).
- 2. Roofing Membrane Cap Sheet: ASTM D 6164, Grade G, Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified. Basis of Design: [DynaWeld Cap 180FR](#)

## 2.4 BASE FLASHING SHEET MATERIALS – SBS

- A. Backer Sheet: ASTM D 6164, Grade S, Type I, polyester-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified. Basis of Design: [DynaWeld 180S](#).

- B. Flashing Sheet: ASTM D 6164, Grade G, Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified. Basis of Design [DynaWeld Cap 180FR](#)

- C. Liquid Applied Flashing: A liquid and fabric reinforced flashing system created with a stitchbonded polyester scrim and a two-component, moisture cured, elastomeric, liquid applied flashing material, consisting of an asphalt extended urethane base material and an activator. Basis of Design: [PermaFlash System](#)

## 2.5 AUXILIARY ROOFING MEMBRANE - Bituminous

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with built-up roofing.

- B. Asphalt Primer: ASTM D 41. Basis of Design: [Asphalt Primer](#)

- C. Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application. Basis of Design: [Bestile Industrial Roof Cement](#) or architect pre-approved equal

- D. Cold-Applied Adhesive: ASTM D3019, Type III, Grade 2. asphalt-based, asbestos-free, cold-

applied adhesive specially formulated for compatibility and use with membrane applications. Basis of Design: [MBR Cold Application Adhesive](#)

- E. Cold-Applied Adhesive: Roofing system manufacturer's asphalt-based, two- component, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with membrane applications. Basis of Design: [MBR Bonding Adhesive](#)
- F. Cold-Applied Flashing Adhesive: Roofing system manufacturer's asphalt-based, two- component, asbestos-free, trowel-grade, cold-applied adhesive specially formulated for compatibility and use with flashing applications. Basis of Design: [MBR Flashing Cement](#)
- G. Mastic Sealant: As required by Johns Manville.
- H. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roofing membrane components to substrate, tested by manufacturer for required pullout strength, and provided by the roofing system manufacturer. Basis of Design: [UltraFast Fasteners and Plates](#)
- I. Roofing Granules: Ceramic-coated roofing granules matching specified cap sheet, provided by roofing system manufacturer.
- J. Coating: Acrylic elastomeric coating with unique bleed-blocking properties particularly well suited for coating over asphalt surfaces. Basis of Design: JM CR Seam Coating
- K. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

## 2.6 AUXILIARY ROOFING System Components

- A. Expansion Joints: Provide factory fabricated weatherproof, exterior covers for expansion joint openings consisting of flexible rubber membrane, supported by a closed cell foam to form flexible bellows, with two metal flanges, adhesively and mechanically combined to the bellows by a bifurcation process. Provide product manufactured and marketed by single-source membrane supplier that is included in the No Dollar Limit guarantee. Basis of Design: [Expand-O-Flash](#)
- B. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing and Trim."

## 2.7 WALKWAYS

- A. Walkway Pads: Mineral-granule-surfaced, reinforced modified asphalt composition, slip-resisting pads, manufactured as a traffic pad for foot traffic provided by roofing system manufacturer, with a pad size of 32-inch x 32 inch. Basis of Design: [Johns Manville DynaTred](#)

## 2.8 COVER BOARD

- A. Gypsum Board: ASTM C1278, non-faced, gypsum and cellulose fiber substrate, 1/4 inch (6



mm). Basis of Design: JM [Securock](#) Gypsum-Fiber RoofBoard.

## 2.9 ROOF INSULATION

- A. General: Refer to Section 035216 – Lightweight Insulating Concrete.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. With Installer present, examine all substrates, areas, and conditions for compliance with the following requirements and all other conditions affecting performance of roofing system have been met:
1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof drain bodies are securely clamped in place.
  2. Verify that cants, blocking, curbs, and nailers (nailers are not required on lightweight insulating concrete decks or on non-insulated, nailable decks) are securely anchored to roof deck at penetrations, area dividers, and terminations and that nailers match thicknesses of insulation.
  3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section “Steel Decking.”
  4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
  5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.
    - a. Test for moisture by pouring 1 pint of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
  6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
1. The owner will require a water test to ensure that the roof contains no ponding water.
  2. Flood Test will not be permitted as a watertest.
- C. Proceed with installation only after unsatisfactory conditions have been corrected in a manner acceptable to the Installer, and in compliance with manufacturer's warranty requirements.
1. Beginning of installation means Installer accepts existing surface and/or substrate conditions.

### 3.2 PREPARATION

- A. Prior to installation, the Contractor is solely responsible for verifying substrate conditions and ensuring that the new roof system has adequate and proper drainage. The Drawings and Specifications indicate MINIMUM requirements, and the Contractor shall provide all materials and services necessary to create the specified drainage.
- B. Clean substrate of all dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- C. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- D. Prime surface of concrete deck with asphalt primer at a rate of 3/4-gal./100 sq. ft. or as otherwise directed by the manufacturer and allow primer to dry.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 COVER BOARD INSTALLATION

- A. Coordinate installing membrane roofing system components so cover board is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof cover board.
- C. Install cover board with long joints of cover board in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with cover board.
  - 1. Cut and fit cover board within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- D. Trim surface of cover board where necessary at roof drains so completed surface is flush and does not restrict flow of water.
  - 1. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- E. Adhered Cover Board Over Concrete Deck: Adhere cover board to substrate as follows:
  - 1. Install in two-part urethane adhesive in continuous .75inch wide ribbons, 12 inches o.c. according to roofing system manufacturer's instruction.

### 3.4 INSTALLATION, GENERAL

- A. Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

- B. Where roof slope exceeds 1/2-inch per 12-inches, install roofing membrane sheets parallel with slope.
- C. Cooperate with any testing and inspecting agencies engaged or required to perform services for installing roofing system.
- D. Coordinate installing roofing system, so components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
  - 1. Provide tie-offs at end of each day's work, or when precipitation is imminent, to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
  - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
  - 3. Remove and discard temporary seals before beginning work on adjoining roofing.
- E. Substrate – Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

### 3.5 ROOF MEMBRANE INSTALLATION

- A. Membrane Application: Apply roofing in accordance with roofing system manufacturer's instructions and the following requirements. Application of roofing membrane components shall immediately follow application of base sheet and/or insulation as a continuous operation.
- B. Aesthetic Considerations: An aesthetically pleasing overall appearance of the finished roof application is a standard requirement for this project. Make necessary preparations, utilize recommended application techniques, apply the specified materials (i.e. granules, metallic powder, etc.), and exercise care in ensuring that the finished application is acceptable to the Architect and Owner.
- C. Priming: Prime metal flanges, including all jacks, edge metal, drain flashings, etc., and concrete and masonry surfaces with a uniform coating of ASTM D 41 asphalt primer.

### 3.6 SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

- A. Install one modified bituminous roofing membrane ply sheet and one modified bituminous roofing membrane cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
  - 1. Torch apply JM DynaWeld to JM Securock coverboard according to roofing system manufacturer's instruction.
  - 2. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.
- B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.

1. Repair tears and voids in laps and lapped seams not completely sealed.
  2. Apply roofing granules to cover exuded bead at laps while bead is hot.
- C. Install roofing membrane sheets so side and end laps shed water.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Bitumen Consistency: Cutting or alterations of bitumen, primer, and sealants will not be permitted.
- F. Roofing Application: Apply all layers of roofing free of wrinkles, creases or fishmouths. Exert sufficient pressure on the roll during application to ensure prevention of air pockets.
1. Apply all layers of roofing perpendicular to the slope of the deck.
  2. Fully bond the base ply to the prepared substrate, utilizing minimum 3-inch side and end laps, unless specified otherwise.
  3. Fully bond the finish ply to the base ply, utilizing minimum 3-inch side and end laps, unless specified otherwise.
  4. Maximum sheet lengths and special fastening of the specified roof membrane system may be required at various slope increments where the roof deck slope exceeds 1/2-inch per foot. The manufacturer shall provide acceptable sheet lengths and the required fastening schedule for all roofing sheet applications to applicable roof slopes.
  5. Granule Embedment: Broadcast mineral granules over all bitumen overruns on the finish ply surface, while the bitumen is still hot, to ensure a monolithic surface color.

### 3.7 FLASHING AND STRIPPING INSTALLATION

- A. General: Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates. Prime substrates with asphalt primer if required by roofing system manufacturer.
- B. Masonry Surfaces: Flash masonry parapet walls and curbs using the reinforcing sheet and the granule-surfaced flashing membrane. Fully adhere the reinforcing sheet per manufacturer's recommendations. Stagger the laps of the flashing sheet layer from the lap seams in the reinforcing ply. Check and seal all loose laps and edges. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing. Seal top termination of base flashing with a strip of glass-fiber fabric set in MBR Flashing cement.
- C. Wood Surfaces: Flash wood or plywood parapet walls and curbs using the reinforcing sheet and the granule-surfaced flashing membrane. Apply the reinforcing sheet per manufacturer's recommendations. Fully adhere the remainder of sheet that extends over the base ply. Stagger the laps of the flashing sheet layer from the lap seams in the reinforcing ply. Check and seal all loose laps and edges. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing. Seal top termination of base flashing with a strip of glass-fiber fabric set in MBR Flashing cement.
- D. Granule Embedment: Broadcast mineral granules over all bitumen overruns on the flashing

membrane, while the bitumen is still hot, to ensure a monolithic surfacecolor.

- E. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.
- F. Roof Drains: Flash drain using PermaFlash system. Clamp roofing membrane, flashing, and stripping into roof-drain clamping ring.
  - 1. Install stripping according to roofing system manufacturer's written instructions.
  - 2. Roof drain sumps are to be 4'x4' to engage movement.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.8 ROOF SYSTEM INTERFACE WITH RELATED COMPONENTS

- A. Lead Pipe Flashings: Completely prime the lead flanges and allow to dry prior to installation. After the base ply has been applied, set the flange in mastic and strip-in the flange using the stripping-ply material, extending a minimum of 4-inches beyond the edge of the flange. Terminate the finish ply at the flange-sleeve juncture of the pipe flashing. Refer to paragraph "Sealant" below for finish of this detail.
- B. Roof Moisture Relief Vents (Vented Lightweight Insulating Concrete Substrates): Completely prime the metal flanges and allow to dry prior to installation. After the base ply has been applied, mark the venting designations. Cut a 2-inch diameter core from the roof membrane assembly. Set the vent flange in mastic, centered over the core cut. Strip-in the flange using the stripping-ply material, extending a minimum of 4- inches beyond the edge of the flange. Terminate the finish ply at the flange-throat juncture of the vent. Refer to paragraph "Sealant" below for finish of this detail.
- C. Sealant: Caulk all exposed finish ply edges at the transition to metal flashings incorporated into the roof system with a smooth continuous bead of the specified sealant. Refer to Division 07 Section "Joint Sealants."

### 3.9 WALKWAY INSTALLATION

- A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
  - 1. Sweep away loose aggregate surfacing and set walkway pads in additional flood coat of hot roofing asphalt.
- B. Walkway Cap Sheet Strips: Install roofing membrane walkway cap sheet strips over roofing membrane in cold-applied adhesive or by torch application. –SBS
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.10 FIELD QUALITY CONTROL

- A. Site Condition: Leave all areas around job site free of debris, roofing materials, equipment, and related items after completion of job.
- B. Testing Agency: Owner will engage a qualified testing agency to provide the following:
  - 1. Continuous visual examination/inspections of roofing installation.
  - 2. Tests to evaluate problems observed during such quality-assurance inspections
  - 3. Prepare test reports with copy to Architect and Owner
- C. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
  - 1. Approximate quantities of components within roofing membrane will be determined according to ASTM D3617.
  - 2. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
- D. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to roofing system manufacturer's written instructions and warranty requirements.
- E. Notification of Completion: Notify the manufacturer by means of manufacturer's printed Notification of Completion form of job completion in order to schedule a final inspection date.
- F. Final Inspection:
  - 1. Post-Installation Inspection Meeting: Hold a meeting at the completion of the project, attended by all parties that were present at the pre-installation meeting. A punch list of items required for completion shall be compiled by the Contractor and the roofing system manufacturer's technical personnel. Complete, sign, and mail the punch list form to the manufacturer's headquarters, Owner and Architect.
    - a. Notify Architect a minimum of 72-hours in advance of date and time of inspection meeting.
- G. Roofing system will be considered defective if it does not pass tests and inspections.
  - 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- H. Issuance of The Guarantee: Complete all post installation procedures and meet the manufacturer's final endorsement for issuance of the specified guarantee.

### 3.11 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075216

## SECTION 076200 - SHEET METAL FLASHING AND TRIM

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

###### 1. Formed Products:

- a. Formed roof drainage sheet metal fabrications.
- b. Formed low-slope roof sheet metal fabrications.

##### B. Related Sections:

1. Division 06 Section "Rough Carpentry " for wood nailers, curbs, and blocking.
2. Division 07 Section 074113 Standing Seam Metal Roof Panels"
3. Division 07 Section 075216 "SBS Modified Bituminous Membrane Roofing" for installing sheet metal flashing and trim integral with membrane roofing.
4. Division 07 Section 077100 "Roof Specialties"
5. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Fabricate and install copings capable of resisting forces shown on the drawings.
- C. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
  1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. Recycled Content of Steel-Sheet Flashing and Trim: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each



manufactured product and accessory.

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- A. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
  - 1. Identification of material, thickness, weight, and finish for each item and location in Project.
  - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
  - 3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
  - 4. Details of termination points and assemblies, including fixed points.
  - 5. Details of special conditions.
  - 6. Details of connections to adjoining work.
  - 7. Detail formed flashing and trim at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- B. Samples for Verification: For each type of exposed finish required
- C. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.
- D. Warranty: Sample of special warranty.

## 2.2 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

## 2.3 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

## 2.4 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.
  - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
  - 2. Surface: Smooth, flat.
  - 3. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 4. Color: As indicated in Section 090690 Color Schedule.
  - 5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil(0.013 mm).

### 2.2 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
  - 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
  - 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29

deg C).

## 2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
    - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  - 2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

## 2.4 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
  - 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with

- performance requirements, but not less than that specified for each application and metal.
  2. Obtain field measurements for accurate fit before shop fabrication.
  3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
  4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- C. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

## 2.5 ROOF DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
1. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:
    - a. Galvanized Steel: 0.028 inch (0.71 mm) thick.
- B. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Fabricate from the following materials:
    - a. Galvanized Steel: 0.022 inch (0.56 mm) thick.

## 2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing: Fabricate from the following materials:
  - 1. Galvanized Steel: 0.034 inch (0.86 mm) thick.
- B. Counterflashing: Fabricate from the following materials:
  - 1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
  - 1. Verify compliance with requirements for installation tolerances of substrates.
  - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 UNDERLAYMENT INSTALLATION

- A. General: Install underlayment as indicated on Drawings.
- B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

### 3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - 1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.

- Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
  4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
  5. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
1. Coat back side of sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing metal flashing directly on wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
- E. Seal joints as shown and as required for watertight construction.
1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
  2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

### 3.4 ROOF DRAINAGE SYSTEM INSTALLATION

- A. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored straps spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
1. Fasten gutter spacers to front and back of gutter.
  2. Loosely lock straps to front gutter bead and anchor to roof deck.
  3. Anchor and loosely lock back edge of gutter to continuous cleat.
  4. Anchor gutter with spikes and ferrules spaced not more than 24 inches (600 mm) apart.
  5. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet

- (15.24 m) apart. Install expansion-joint caps.
6. Install wire ball strainers of compatible metal at outlets wire ball strainers of compatible metal at outlets.

B. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints.

1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
2. Provide elbows at base of downspout to direct water away from building.

### 3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 24-inch (600-mm) centers.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with sealant. Secure in a waterproof manner by means of interlocking folded seam or blind rivets and sealant.

### 3.6 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

### 3.7 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.

- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200



## SECTION 077100 - ROOF SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Copings.
2. Roof-edge specialties.
3. Roof-edge drainage systems.
4. Reglets and counter-flashings.

##### B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
3. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
4. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

##### C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

##### B. Shop Drawings: For roof specialties.

1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.

2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Detail termination points and assemblies, including fixed points.
5. Include details of special conditions.

C. Samples: For each type of roof specialty and for each color and texture specified.

### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.
- B. Source Limitations: Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing."

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

### 1.5 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

### 1.6 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing."
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
  1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.

- b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
  - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

### 2.2 COPINGS

- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
  1. Metallic-Coated Steel Sheet Coping Caps: Zinc-coated (galvanized) steel, nominal 0.028-inch (0.71-mm) thickness.
    - a. Surface: Smooth, flat finish.
    - b. Finish: Two-coat fluoropolymer.
    - c. Color: Match Owner's sample.
  2. Corners: Factory mitered and soldered.
  3. Special Fabrications: Radiussed sections.
  4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.
    - a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

### 2.3 ROOF-EDGE SPECIALTIES

- A. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous metal receiver with

integral drip-edge cleat to engage fascia cover [and secure single-ply roof membrane]. Provide matching corner units.

1. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal 0.028-inch (0.71-mm) thickness.
  - a. Surface: Smooth, flat finish.
  - b. Finish: Two-coat fluoropolymer.
  - c. Color: Match Owner's sample.
2. Corners: Factory mitered and soldered.
3. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
4. Receiver: Galvanized-steel sheet, nominal 0.040-inch (1.02-mm) thickness.

## 2.4 ROOF-EDGE DRAINAGE SYSTEMS

- A. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
  1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
  2. Gutter Profile: Style A according to SMACNA's "Ownerural Sheet Metal Manual."
  3. Corners: Factory mitered and soldered.
  4. Gutter Supports: Gutter brackets with finish matching the gutters.
  5. Gutter Accessories: Wire ball downspout strainer.
- B. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
  1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
- C. Zinc-Coated Steel Finish: Two-coat fluoropolymer.
  1. Color: Match Owner's sample.

## 2.5 REGLETS AND COUNTERFLASHINGS

- A. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
  1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
  2. Corners: Factory mitered and soldered.
  3. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
- B. Counter-flashings: Manufactured units of heights to overlap top edges of base flashings by 4

inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:

1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.

C. Zinc-Coated Steel Finish: Two-coat fluoropolymer.

1. Color: Match Owner's sample.

## 2.6 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation.

## 2.7 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 deg F (116 deg C).
2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F (29 deg C).

## 2.8 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.

- B. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

- C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

- E. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

## 2.9 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Owner and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Coil-Coated Galvanized-Steel Sheet Finishes:
  - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A755/A755M and coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments].
    - b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

1. Apply continuously under copings roof-edge specialties and reglets and counter-flashings.

### 3.3 INSTALLATION, GENERAL

- A. Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
  2. Provide uniform, neat seams with minimum exposure of solder and sealant.
  3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
  4. Torch cutting of roof specialties is not permitted.
  5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
  2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

### 3.4 INSTALLATION OF COPINGS

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
  - 1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at 30-inch (762-mm) centers .

### 3.5 INSTALLATION OF ROOF-EDGE SPECIALITIES

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

### 3.6 INSTALLATION OF ROOF-EDGE DRAINAGE-SYSTEM

- A. Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches (610 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
  - 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.

### 3.7 INSTALLATION OF REGLETS AND COUNTERFLASHINGS

- A. Coordinate installation of reglets and counter-flashings with installation of base flashings.
- B. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counter-flashings overlap 4 inches (100 mm) over top edge of base flashings.
- C. Counter-flashings: Insert counter-flashings into reglets or other indicated receivers; ensure that counter-flashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with butyl sealant. Fit counter-flashings tightly to base flashings.



3.8 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

## SECTION 078400 - FIRESTOPPING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of all joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.

#### 1.2 RELATED REQUIREMENTS

- A. Section 017000 - Execution and Closeout Requirements: Cutting and patching.
- B. Section 070533 - Fire and Smoke Assembly Identification.
- C. Section 078100 - Applied Fireproofing.

#### 1.3 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2015.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
- C. ASTM E1966 - Standard Test Method for Fire Resistive Joint Systems; 2007 (Reapproved 2011).
- D. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2015a.
- E. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2013.
- F. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.
- G. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- H. FM 4991 - Approval Standard for Firestop Contractors; Factory Mutual Research Corporation; 2013.
- I. FA (AG) - FM Approval Guide; Factory Mutual Research Corporation; current edition.
- J. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; [www.aqmd.gov](http://www.aqmd.gov).
- K. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- L. UL (DIR) - Online Certifications Directory; Underwriters Laboratories Inc.; current listings at [database.ul.com](http://database.ul.com).
- M. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

#### 1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Sustainable Design Submittal: Submit VOC content documentation for all non-preformed materials.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Certificate from authority having jurisdiction indicating approval of materials used.

#### 1.5 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.

1. Listing in the current-year classification or certification books of UL or FM will be considered as constituting an acceptable test report.
2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at [www.icc-es.org](http://www.icc-es.org) will be considered as constituting an acceptable test report.
3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section and:

1. Trained by the manufacturer.
2. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
3. With minimum 3 years documented experience installing work of this type.
4. Able to show at least 5 satisfactorily completed projects of comparable size and type.
5. Licensed by authority having jurisdiction.

#### 1.6 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.

1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.

B. Obtain approval of authorities having jurisdiction (AHJ) before proceeding.

C. If accepted, mock-up will represent minimum standard for the Work.

D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

#### 1.7 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

### PART 2 PRODUCTS

#### 2.1 FIRESTOPPING - GENERAL REQUIREMENTS

A. Manufacturers:

1. Hilti, Inc: [www.us.hilti.com/#sle](http://www.us.hilti.com/#sle).
2. Specified Technologies, Inc: [www.stifirestop.com](http://www.stifirestop.com).
3. A/D Fire Protection Systems Inc: [www.adfire.com](http://www.adfire.com). A/D Fire Protection Systems Inc: [www.adfire.com](http://www.adfire.com).
4. 3M Fire Protection Products: [www.3m.com/firestop](http://www.3m.com/firestop).

B. Firestopping: Manufactured device.

C. Firestopping Materials with Volatile Content: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

D. Mold Resistance: Provide firestopping materials with mold and mildew resistance rating of 0 as determined by ASTM G21.

- E. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.
- F. Fire Ratings: Refer to drawings for required systems and ratings.

## 2.2 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use any system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of the floor assembly.
  - 1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
  - 2. Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
  - 3. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
  - 4. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated.
- B. Head-of-Wall Firestopping at Joints Between Non-Rated Floor and Fire-Rated Wall: Use any system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.
  - 1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
- C. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use any system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
  - 1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
  - 2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
  - 3. Watertightness: In addition, provide systems that have been tested to show W Rating as indicated.
  - 4. Listing by FM, ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.
- D. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
  - 1. Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
  - 2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
  - 3. Watertightness: In addition, provide systems that have been tested to show W Rating as indicated.
  - 4. Listing by FM, ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

## 2.3 FIRESTOPPING FOR FLOOR-TO-FLOOR, WALL-TO-FLOOR, AND WALL-TO-WALL JOINTS

- A. Concrete and Concrete Masonry Walls and Floors:
  - 1. Floor to Floor Joints:
    - a. 2 Hour Construction: UL System FF-D-1013; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - 2. Top of Wall Joints at Concrete/Concrete Masonry Wall to Concrete Over Metal

Deck Floor:

- a. 2 Hour Construction: UL System HW-D-0181; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
- b. 2 Hour Construction: UL System HW-D-1037; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
3. Top of Wall Joints at Concrete/Concrete Masonry Wall to Concrete Floor:
  - a. 3 Hour Construction: UL System HW-D-1058; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - b. 2 Hour Construction: UL System HW-D-0268; Hilti CP 606 Flexible Firestop Sealant.
4. Concrete/Concrete Masonry Wall to Wall Joints:
  - a. 2 Hour Construction: UL System WW-D-0017; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - b. 2 Hour Construction: UL System WW-D-0032; Hilti CP 606 Flexible Firestop Sealant.

B. Gypsum Board Walls:

1. Wall to Wall Joints:
  - a. 2 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
  - b. 1 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
2. Top of Wall Joints at Underside of Steel Beam and Concrete Over Metal Deck Floor with Sprayed On Fireproofing:
  - a. 2 Hour Construction: UL System HW-D-0259; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - b. 1 Hour Construction: UL System HW-D-0259; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
3. Top of Wall Joints at Underside of Flat Concrete:
  - a. 2 Hour Construction: UL System HW-D-1068; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - b. 1 Hour Construction: UL System HW-D-1068; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
4. Top of Wall Joints at Concrete Over Metal Deck, Wall Parallel to Ribs:
  - a. 2 Hour Construction: UL System HW-D-0049; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - b. 2 Hour Construction: UL System HW-D-0184; Hilti CP 606 Flexible Firestop Sealant.
  - c. 1 Hour Construction: UL System HW-D-0049; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - d. 1 Hour Construction: UL System HW-D-0184; Hilti CP 606 Flexible Firestop Sealant.
5. Top of Wall Joints at Concrete Over Metal Deck, Wall Perpendicular to Ribs, Cut to Fit Ribs:
  - a. 2 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
  - b. 1 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
6. Top of Wall Joints at Concrete Over Metal Deck, Wall Perpendicular to Ribs, Not Cut to Fit:
  - a. 2 Hour Construction: UL System HW-D-0042; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - b. 2 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
  - c. 1 Hour Construction: UL System HW-D-0042; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
  - d. 1 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.

2.4 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

A. Blank Openings:

1. In Floors or Walls:
  - a. 2 Hour Construction: UL System C-AJ-0090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
- B. Penetrations Through Floors or Walls By:
  1. Multiple Penetrations in Large Openings:
    - a. 3 Hour Construction: UL System C-AJ-8099; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - b. 3 Hour Construction: UL System C-AJ-8110; Hilti CFS-BL Firestop Block.
    - c. 2 Hour Construction: UL System C-AJ-8143; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  2. Bathtub Drains:
    - a. Up to 3 Hour Construction: UL System F-A-1037, F-A-1038, F-A-2094, or F-A-2095; Hilti CP 681 Tub Box Kit.
  3. Uninsulated Metallic Pipe, Conduit, and Tubing:
    - a. 3 Hour Construction: UL System C-AJ-1184; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - b. 3 Hour Construction: UL System C-AJ-1226; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - c. 3 Hour Construction: UL System C-AJ-1421; Hilti FS-ONE MAX Intumescent Firestop Sealant or CP 604 Self-Leveling Firestop Sealant.
    - d. 3 Hour Construction: UL System C-AJ-1425; Hilti CFS-S SIL GG Firestop Silicone Sealant Gun-Grade.
    - e. 2 Hour Construction: UL System C-AJ-1226; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - f. 2 Hour Construction: UL System C-AJ-1425; Hilti CFS-S SIL GG Firestop Silicone Sealant Gun-Grade.
  4. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
    - a. 3 Hour Construction: UL System C-AJ-2109; Hilti CP 643N/644 Firestop Collar.
    - b. 3 Hour Construction: UL System C-AJ-2220; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - c. 3 Hour Construction: UL System C-AJ-2342; Hilti CP-E/S Firestop Wrap Strip.
    - d. 2 Hour Construction: UL System C-AJ-2109; Hilti CP 643N/644 Firestop Collar.
    - e. 2 Hour Construction: UL System C-BJ-2021; Hilti CP 643N Firestop Collar.
  5. Electrical Cables Not In Conduit:
    - a. 3 Hour Construction: UL System C-AJ-3208; Hilti CP 618 Firestop Putty Stick.
    - b. 2 Hour Construction: UL System C-AJ-3216; Hilti CFS-PL Firestop Plug.
    - c. 2 Hour Construction: UL System W-J-3198; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
    - d. 2 Hour Construction: UL System W-J-3199; Hilti CFS-SL SK Firestop Sleeve Kit.
    - e. 2 Hour Construction: UL System C-AJ-3283; Hilti CP653 Speed Sleeve.
  6. Cable Trays with Electrical Cables:
    - a. 3 Hour Construction: UL System C-AJ-4093; Hilti CFS-BL Firestop Block.
    - b. 2 Hour Construction: UL System C-AJ-4094; Hilti CFS-BL Firestop Block.
  7. Electrical Busways:
    - a. 3 Hour Construction: UL System C-AJ-6017; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  8. Insulated Pipes:
    - a. 3 Hour Construction: UL System C-AJ-5090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  9. HVAC Ducts, Uninsulated:

- a. 2 Hour Construction: UL System C-AJ-7111; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  - b. 3 Hour Construction: UL System C-AJ-7051; Hilti FS-ONE MAX Intumescent Firestop Sealant.
- C. Penetrations Through Floors By:
1. Multiple Penetrations in Large Openings:
    - a. 3 Hour Construction: UL System F-A-1023; Hilti CP 680-P/M Cast-In Device.
    - b. 2 Hour Construction: UL System F-A-8012; Hilti CFS-S SIL GG Firestop Silicone Sealant Gun-Grade or CFS-S SIL SL Firestop Silicone Sealant Self-Leveling.
  2. Uninsulated Metallic Pipe, Conduit, and Tubing:
    - a. 3 Hour Construction: UL System F-A-1017; Hilti CP 680-P/M Cast-In Device.
    - b. 2 Hour Construction: UL System F-A-1016; Hilti CP 680-P/M Cast-In Device.
  3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
    - a. 3 Hour Construction: UL System F-A-2054; Hilti CP 680-P Cast-In Device.
    - b. 2 Hour Construction: UL System F-A-2065; Hilti CP 680-P Cast-In Device.
    - c. 2 Hour Construction: UL System F-A-2213; Hilti CFS-DID Drop-In Device.
    - d. 2 Hour Construction: UL System F-A-2053; Hilti CP 680-P Cast-In Device.
  4. Electrical Cables Not In Conduit:
    - a. 3 Hour Construction: UL System F-A-3033; Hilti CP 680-P/M Cast-In Device.
    - b. 2 Hour Construction: UL System F-A-3033; Hilti CP 680-P/M Cast-In Device.
  5. Electrical Busways:
    - a. 3 Hour Construction: UL System C-AJ-6017; Hilti CFS-S SIL GG Firestop Silicone Sealant Gun-Grade or CFS-S SIL SL Firestop Silicone Sealant Self-Leveling.
    - b. 2 Hour Construction: UL System F-A-6002; Hilti CP 604 Self-Leveling Firestop Sealant.
  6. Insulated Pipes:
    - a. 3 Hour Construction: UL System F-A-5018; Hilti CP 680-P Cast-In Device.
    - b. 2 Hour Construction: UL System F-A-5015; Hilti CP 680-P/M Cast-In Device.
    - c. 2 Hour Construction: UL System F-A-5017; Hilti CP 680-P/M Cast-In Device.
- D. Penetrations Through Walls By:
1. Uninsulated Metallic Pipe, Conduit, and Tubing:
    - a. 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - b. 1 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  2. Electrical Cables Not In Conduit:
    - a. 2 Hour Construction: UL System C-AJ-3095; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - b. 2 Hour Construction: UL System C-AJ-3216; Hilti CFS-PL Firestop Plug.
  3. Insulated Pipes:
    - a. 2 Hour Construction: UL System C-AJ-5090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - b. 2 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - c. 1 Hour Construction: UL System C-AJ-5090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
    - d. 1 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE MAX Intumescent Firestop Sealant.

4. HVAC Ducts, Uninsulated:
  - a. 2 Hour Construction: UL System W-J-7109; Hilti FS-ONE MAX Intumescent Firestop Sealant or CP 606 Flexible Firestop Sealant.
5. HVAC Ducts, Insulated:

## 2.5 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

### A. Penetrations By:

1. Multiple Penetrations in Large Openings:
  - a. 2 Hour Construction: UL System W-L-8013; Hilti CFS-BL Firestop Block.
  - b. 1 Hour Construction: UL System W-L-8071; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  - c. 1 Hour Construction: UL System W-L-8013; Hilti CFS-BL Firestop Block.
2. Uninsulated Metallic Pipe, Conduit, and Tubing:
  - a. 2 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  - b. 2 Hour Construction: UL System W-L-1164; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  - c. 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  - d. 1 Hour Construction: UL System W-L-1164; Hilti FS-ONE MAX Intumescent Firestop Sealant.
3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
  - a. 2 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
  - b. 2 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  - c. 1 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
  - d. 1 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
4. Electrical Cables Not In Conduit:
  - a. 2 Hour Construction: UL System W-L-3065; Hilti FS-ONE MAX Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
  - b. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
  - c. 2 Hour Construction: UL System W-L-3393; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
  - d. 2 Hour Construction: UL System W-L-3395; Hilti CP653 Speed Sleeve.
  - e. 1 Hour Construction: UL System W-L-3393; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
  - f. 1 Hour Construction: UL System W-L-3065; Hilti FS-ONE MAX Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
5. Cable Trays with Electrical Cables:
  - a. 2 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
  - b. 2 Hour Construction: UL System W-L-4060; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  - c. 1 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
  - d. 1 Hour Construction: UL System W-L-4060; Hilti FS-ONE MAX Intumescent Firestop Sealant.
6. Insulated Pipes:
  - a. 2 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.



- b. 1 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.
- c. 1 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.

## 2.6 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
  - 1. Fire Ratings: Use any system that is listed by FM, ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814 or ASTM E119 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

### 3.2 STENCILING OF RATED WALLS

- A. Marking and identification. Fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling. Such identification shall:
  - 1. Be located in accessible concealed floor, floor-ceiling or attic spaces;
  - 2. Be located within 15 feet (4572 mm) of the end of each wall and at intervals not exceeding 30 feet (9144 mm) measured horizontally along the wall or partition; and
  - 3. Include lettering not less than 3 inches (76 mm) in height with a minimum 3/8 inch (9.5 mm) stroke in a contrasting color incorporating the suggested wording. "FIRE AND/OR SMOKE BARRIER-PROTECT ALL OPENINGS" or other wording.
- B. Exception: Walls in Group R-2 occupancies that do not have a removable decorative ceiling allowing access to the concealed space

### 3.3 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to arrest liquid material leakage.

### 3.4 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.
- C. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- D. Install labeling required by code.

### 3.5 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174, "Standard Practice for On-Site Inspection of Installed Fire Stops and ASTM E2393, "Standard Practice for On-Site Inspection of Installed Fire Stop Joint Systems.
- B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

### 3.6 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.7 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF  
SECTION

## SECTION 079200 - JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Silicone joint sealants.
  2. Urethane joint sealants.
  3. Latex joint sealants.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
  2. Joint-sealant manufacturer and product name.
  3. Joint-sealant formulation.
  4. Joint-sealant color.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

## 1.5 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
  2. When joint substrates are wet.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## 1.6 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  2. Disintegration of joint substrates from natural causes exceeding design specifications.
  3. Mechanical damage caused by individuals, tools, or other outside agents.
  4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40

CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
  2. Sealant Primers for Nonporous Substrates: 250 g/L.
  3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Colors of Exposed Joint Sealants: As indicated in Section 090690 Color Schedule.

## 2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
- B. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

## 2.3 URETHANE JOINT SEALANTS

- A. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

## 2.4 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

## 2.5 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.6 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint

- sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    - a. Concrete.
      3. Remove laitance and form-release agents from concrete.
      4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
        - a. Metal.
  - B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
  - C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.
- ### 3.3 INSTALLATION OF JOINT SEALANTS
- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
  - B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
  - C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
    1. Do not leave gaps between ends of sealant backings.
    2. Do not stretch, twist, puncture, or tear sealant backings.
    3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
  - D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
  
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
  - 4. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
    - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

### 3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

### 3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 1. Joint Locations:
    - a. Joints between metal panels.
    - b. Perimeter joints between materials listed above and frames of doors, windows and louvers.
    - c. Other joints as indicated.



2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 50.
  3. Joint-Sealant Color: As indicated in Section 090690 Color Schedule.
- B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
    - a. Isolation joints in cast-in-place concrete slabs.
    - b. Other joints as indicated.
  2. Urethane Joint Sealant: Multicomponent, nonsag, traffic grade, Class 25.
  3. Joint-Sealant Color: As indicated in Section 090690 Color Schedule.
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
    - a. Perimeter joints of exterior openings where indicated.
    - b. Other joints as indicated.
  2. Joint Sealant: Latex, Acrylic based.
  3. Joint-Sealant Color: As indicated in Section 090690 Color Schedule.
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.
  2. Joint-Sealant Color: As indicated in Section 090690 Color Schedule.

END OF SECTION 079200

***DIVISION 8***

***DOORS AND WINDOWS***

## SECTION 081113 HOLLOW METAL DOORS AND FRAMES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Work under this section comprises of furnishing hollow metal doors and frames, including transom frames, sidelight and window frames with provision for glazed, paneled or louvered openings, fire labeled and non-labeled, as scheduled.
1. Flush Steel Doors.
  2. Steel frames.
  3. Hollow Metal Framing Systems.
- B. Related Sections: Related documents, drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 specification sections apply to this section. The latest published edition of each reference applies.
1. Section 06 10 00 - Rough Carpentry
  2. Section 08 11 19 – Stainless Steel Doors and Frames
  3. Section 08 14 00 - Wood Doors
  4. Section 08 15 00 – Plastic Doors
  5. Section 08 34 00 – Special Function Doors
  6. Section 08 71 00 - Door Hardware
  7. Section 08 80 00 - Glazing
  8. Section 09 90 00 - Painting and Coating
  9. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables
  10. Section 28 10 00 – Access Control
- C. References: The intent of this document is that all hollow metal and its application will comply or exceed the standards identified below. The latest published edition of each reference applies.
1. ANSI - American National Standards Institute - [ansi.org](http://ansi.org)
  2. NFPA - National Fire Protection Association
    - a. NFPA 80 - Standard for Fire Doors and Other Opening Protectives, 2013
    - b. NFPA 101 – Life Safety Code, 2010
    - c. NFPA 105 – Standard Smoke Door Assemblies and Other Opening Protectives
    - d. NFPA 252 - Standard Method of Fire Tests of Door Assemblies.
  3. DHI - Door and Hardware Institute – Door Security + Safety Professionals
    - a. Installation Guide for Doors and Hardware.
    - b. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
    - c. Recommended Locations for Builders’ Hardware for Custom Steel Doors and Frames.
  4. SDI - Steel Door Institute
    - a. SDI-105 – Recommended Erection Instructions for Steel Frames
    - b. SDI-107 – Hardware on Steel Doors (Reinforcement - Application)
    - c. SDI-111 - Recommended Details for Standard Steel Doors, Frames, Accessories, and

- Related Components
  - d. SDI-117 - Manufacturing Tolerances Standard Steel Doors and Frames
  - e. SDI-118 – Basic Fire Door Requirements
  - f. SDI A250.3 Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames
  - g. SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, and Frame Anchors
  - h. SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
  - i. SDI A250.8 - SDI-100 Specifications for Standard Steel Doors and Frames
  - j. SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
  - k. SDI A250.11 - Recommended Erection Instructions for Steel Frames
  - l. SDI A250.13 Testing and Rating of Severe Windstorm Resistant Components for Swinging Door Assemblies
5. BHMA - Builders Hardware Manufacturers Association
- a. BHMA A156.115 - Hardware Preparations in Standard Steel Doors and Frames.
  - b. BHMA A156.7 - Hinge Template Dimensions.
6. ASTM - American Society for Testing Materials
- a. ASTM A568/A568M-19a Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements
  - b. ASTM A879/A879M-12(2017) Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
  - c. ASTM A653/A653M-19a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - d. ASTM A924/A924M-19 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
  - e. ASTM A1008/A1008M-18 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
7. ICC - International Code Counsel
- a. ICC A117.1 – Accessible and Usable Building and Facilities.
8. UL - Building Materials Directory; Underwriters Laboratories Inc.
- a. UL 10B - Standard for Neutral Pressure Fire Tests of Door Assemblies
  - b. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies
  - c. UL 1784 – Air Leakage Test of Door Assemblies
9. NAAMM/HMMA – National Association of Architectural Metal Manufacturers/Hollow Metal Manufacturers Association
- a. NAAMM/HMMA 840 – Guide Specification for Receipt, Storage, and Installation of Hollow Metal Doors and Frames.

10. WH - Certification Listings; Warnock Hersey International Inc.

1.2 SUBSTITUTIONS:

- A. All substitution requests must be submitted within the procedures and time frame as outlined in Division 1, General Requirements. Approval of products is at the discretion of the architect and their consultant

1.3 SUBMITTALS

- A. Submittals to comply with provisions of Division 01, Submittal Procedures.
- B. Product Data: Manufacturer's standard details and catalog data indicating compliance with referenced standards and manufacturer's installation instructions.
- C. Shop Drawings: Provide a schedule of doors and frames using same reference numbers for details and door openings as those on the contract documents. Shop drawings should include the following information to ensure doors and frames are properly prepared and coordinated to receive hardware.
  - 1. Elevations of each door and frame type.
  - 2. Details for door core.
  - 3. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
  - 4. Locations of cutouts for glass and louvers.
  - 5. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 6. Mounting locations for hardware.
  - 7. Thickness of reinforcement/preparations for hardware.
  - 8. Details of anchorages, joints, field splices, and connections.
  - 9. Details of accessories.
  - 10. Details of moldings, removable stops, and glazing.
  - 11. Fire ratings.
  - 12. Finish.
- D. Samples: 12 by 12 inches (304 mm by 304 mm) cut away sample door with provisions for lockset, hinge and corner section of frame welded and prepped for specified hardware. Sample should be furnished with submittals for Owner approval. After approval return sample to door/frame supplier as confirmation of approved construction.
- E. Closeout Submittals to comply with Division 1, Closeout Submittals procedures.
- F. Furnish copies of manufacturer's warranty information and maintenance instructions.

1.4 QUALITY ASSURANCE

- A. Hollow Metal Distributor is to be a direct account of the manufacturer of the products furnished. In addition, that distributor must have in their regular employment an Architectural Hardware Consultant (AHC), Certified Door Consultant (CDC), an Architectural Openings Consultant (AOC), a Door & Hardware Consultant (DHC) or equivalent door and hardware industry experience who will be available to consult with the Architect and Contractor regarding any matters affecting the door and frame opening.
- B. Manufacturer Qualifications: Certified Member of the Steel Door Institute in good standing.
- C. Installer: Minimum five years documented experience installing products specified this Section.
- D. Certificates:
  - 1. Manufacturer's certification that products comply with referenced standards.

2. Hollow Metal Manufacturer must provide documentation that they are an SDI Certified Manufacturer.
- E. Fire Rated Doors and Frames: Underwriters' Laboratories, Intertek Testing Services/Warnock Hersey, and Factory Mutual labeled fire doors and frames:
1. Provide labeled fire doors and frames in accordance with Underwriters Laboratories standard UL10C Positive Pressure Fire Tests of Door Assemblies.
  2. Construct and install doors and frames to comply with current issue of NFPA 80.
  3. Manufacture Underwriters' Laboratories labeled doors and frames in strict compliance to UL procedures, and provide the degree of fire protection, heat transmission and panic loading capability indicated by the opening class.
  4. Manufacture Intertek Testing Services /Warnock Hersey labeled doors and frames in strict compliance to ITS/WH procedures and provide the degree of fire protection capability indicated by the opening class.
  5. Manufacture Factory Mutual labeled doors and frames in strict compliance to FM procedures, and provide the degree of fire protection, heat transmission and panic loading capability indicated by the opening class.
  6. Affix a physical label or approved marking to each fire door and/or fire door frame, at an authorized facility as evidence of compliance with procedures of the labeling agency.
  7. Conform to applicable codes for fire ratings. It is the intent of this specification that doors, frames, hardware and their application comply or exceed the standards for labeled openings. In case of conflict between types required for fire protection, furnish type required by NFPA and UL.
  8. Provide Temperature Rise Fire Door Assemblies in exit enclosures and exit passageway with maximum transmitted temperature end point rating of not more than 250 degrees F (121 degrees C) above ambient at the end of 30 minutes of the standard fire test exposure.
  9. For openings required to be fire rated exceeding limitations of labeled assemblies, submit manufacturer's certification that each door and frame assembly has been constructed to conform to design, materials and construction equivalent to requirements for labeled construction.
  10. Provide test report data validating compliance.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

##### A. Packing and Shipping

1. The use of non-vented plastic or canvas shelters that can create a humidity chamber shall be avoided to prevent rust or damage.
2. Provide cardboard wrapped or crated product to provide protection during transit and job site storage
3. Should wrappers become wet, remove immediately

##### B. Delivery and Site Acceptance

1. The supplier shall deliver all materials to the project site; direct factory shipments are not allowed unless agreed upon beforehand. Supplier shall coordinate delivery times and schedules with the contractor.
2. Deliver doors cardboard wrapped or crated to provide protection during transit and job site storage. Provide additional protection to prevent damage to any factory-finished doors.

Mark all doors and frames with architects opening numbers as shown on the contract documents and shop drawings on the center hinge preparation location.

3. Upon delivery, check in doors and frames jointly with supplier. Inspect doors and frames upon delivery for damage, correct quantities or shortages. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to the architect. Otherwise, remove and replace damaged goods as directed. Note shortages and replace immediately.

C. Storage and Protection

1. Handle, store and protect products in accordance with the manufacturers printed instructions, ANSI/SDI A250.8 – Specifications for Standard Steel Doors and Frames, A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames, or ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames and NAAMM/HMMA 840 – Guide Specification for Receipt, Storage, and Installation of Hollow Metal Doors and Frames.
2. Store all materials in a dry area. All hollow metal material shall be stored so that it does not come in contact with water or moisture. Protect units from adverse weather elements.
3. Place units on 4 inch (102 mm) high wood sills to prevent rust and damage.
4. Store doors vertically under a properly vented cover, five units maximum in a stack with a ¼” space between doors to permit air circulation.
5. Store frames in an upright position with heads uppermost under cover.
6. Store assembled frames five units maximum in a stack with 2-inch (51 mm) space between frames to permit air circulation.

1.6 COORDINATION

- A. Coordinate Work with other directly affected sections involving manufacture or fabrication of internal cutouts and reinforcement for door hardware, electric devices and recessed items.
- B. Coordinate Work with frame opening construction, door and hardware installation.
- C. Sequence installation to accommodate required door hardware.
- D. Verify field dimensions for factory assembled frames prior to fabrication.

1.7 WARRANTY

- A. Comply with Division 01 Closeout Submittals
- B. All doors and frames shall be warranted in writing by the manufacturer against defects in materials and workmanship for a period of one (1) year commencing on the date of manufacture.

**PART 2 PRODUCTS**

2.1 MANUFACTURERS

- A. Basis of Design - MESKER a dormakaba Brand, Web: <http://meskerdoor.com>
  1. Acceptable Manufacturer - Curries an ASSA Abloy Company
  2. Acceptable Manufacturer - Steelcraft an Allegion Company
- B. Provide all steel doors and frames from a single SDI certified manufacturer.

2.2 General:

- A. Physical performance: Units shall comply with the 1 million cycles swing test requirement per

- ANSI A250.4 - Level A.
- B. Finishing:
1. Prime Gray to meet SDI A250.10
- C. Electrical Requirements: Coordinate all electrical requirements for doors and frames. Make provisions for installation of electrical items so that wiring can be readily removed and replaced.
1. Provide cutouts and reinforcements required for metal doors and frames to accept electric components.
  2. Frame with Electrical Hinges: Junction box welded over center hinge reinforcing. Top or bottom hinge locations are not permitted.
  3. Coordinate with Section 08 71 00 (or Division 28) for electrified hardware items.

### 2.3 DOORS

- A. General: Construct exterior/interior doors to the following designs and gauges:
1. Exterior Doors: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A653/A653M:
    - a. Thickness:
      - 1) 16 gauge
    - b. Provide flush top/closed top channel for exterior swing-out doors to eliminate moisture penetration. Galvanized steel top caps are permitted.
  2. Interior Doors: Cold-rolled steel, ASTM A 1008/A 1008M:
    - a. Thickness:
      - 1) 18 gauge
  3. Interior Doors: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A653/A653M at all areas where moisture is a concern:
    - a. Thickness:
      - 1) 18 gauge
  4. Door Thickness: 1-3/4 inches
  5. Vertical edge seams: Provide doors with continuous vertical mechanical inter-locking joints at lock and hinge edges. Finish edges as follows:
    - a. Visible Interlocked Edge: Continuous vertical mechanical interlocking joints with visible edge seams
  6. Bevel hinge and lock door edges 1/8 inch (3 mm) in 2 inches (50 mm). Square edges on hinge and/or lock stiles are acceptable.
  7. Reinforce top and bottom of doors with galvanized 16 gauge minimum, welded to both panels.
  8. Fire Rating: Supply door units bearing Labels for fire ratings indicated in Door Schedule for the locations indicated.
  9. Core Adhesion System – Basis of design - Moisture Cure Polyurethane Hot Melt:
    - a. Adhesives are to cure completely, meaning once set, they cannot be re-melted and



- will not soften or freeze and lose adhesion.
  - b. Adhesive system will have an enhanced resistance to flame spread in its cured state designed to pass UL 10C, Positive Pressure Fire Tests of Door Assemblies.
  - c. Bonded assemblies will withstand prolonged exposure from -35°F(-37°C) to 200°F (93°C) temperatures without exhibiting any signs of bond failure.
  - d. Cured adhesive film will remain flexible to allow for differences in thermal expansion and contraction of various substrates without sacrificing bond performance.
10. Core Material
- a. Treadcore Polystyrene
11. Glass moldings and stops:
- a. Fabricate from 18-gauge minimum steel:
  - b. Install trim into the door as a four-sided welded assembly with mitered, reinforced and welded corners.
  - c. Trim: identical on both sides of the door.
  - d. Labeled and non-labeled doors: use the same trim to match esthetics.
  - e. Channeling requirements:
    - 1) Cutouts larger than 36" in height require 18-gauge perimeter channelings in the cutout of the door prior to installation of the lite kit or louver.
12. Hardware Reinforcements:
- a. Doors shall be mortised and adequately reinforced per the manufacturer's guidelines for all hardware. Required mortise hardware reinforcements shall be drilled and tapped at the factory. Surface applied hardware shall be field drilled by hardware installer.
  - b. Hinge reinforcements for full mortise hinges: minimum 7 gauge with an extra long, high frequency top hinge reinforcement as a standard feature.
  - c. Lock reinforcements : minimum 16 gauge.
  - d. Closer reinforcements: minimum 14-gauge steel.
  - e. Projection welded hinge and lock reinforcements to the edge of the door.
  - f. Provided adequate reinforcements for other hardware as required.
- B. Full Flush Doors:
- 1. Basis of Design: Mesker N Series.
- 2.4 DOOR FRAMES
- A. General: Construct exterior/interior metal door frames to the following designs and gauges;
- 1. Exterior Frames: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M:
    - a. Thickness:
      - 1) 16 gauge.
  - 2. Interior Frames in Masonry: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M:

- a. Thickness:
  - 1) 16 gauge.
3. Interior Frames in stud wall construction: cold rolled steel, ASTM A 1008/A 1008M.
  - a. Thickness:
    - 1) 16 gauge.
4. Interior KD Drywall Frames (Slip-On construction): cold rolled steel, ASTM A 1008/A 1008M.
  - a. Thickness:
    - 1) 16 gauge.
- B. Flush Steel Frames:
  1. Basis of Design: Mesker F-Series.
  2. Profile:
    - a. Face:
      - 1) 2 Inches face dimension and types and throat dimensions indicated on the Door Schedule.
      - 2) Custom special face dimension and types and throat dimensions indicated on the Door Schedule.
    - b. Stops:
      - 1) Standard 5/8-inch-high stops
  3. Provide reinforcements and accessories for specified hardware per SDI 250.6.
  4. Anchors: Locate adjustable anchors in each jamb 6 inches from the top of the door opening to hold frame in rigid alignment.
    - a. Exposed fastener type; recessed hole at base of jamb for countersunk fastener installation.
    - b. Snap in base anchors
    - c. Strap anchors welded to frame
  5. Fire Rating: Supply frame units bearing Labels for fire ratings indicated in Door Schedule for the locations indicated.
- C. Steel Frames for Drywall:
  1. Basis of Design: Mesker FDJ-Series.
  2. Profile:
    - a. Face:
      - 1) 2 Inches face dimension and types and throat dimensions indicated on the Door Schedule.
      - 2) Custom special face dimension and types and throat dimensions indicated on the Door Schedule.
    - b. Stops:
      - 1) Standard 5/8-inch-high stops
  3. Provide reinforcements and accessories for specified hardware per SDI 250.6.

4. Anchors: Locate adjustable anchors in each jamb 6 inches from the top of the door opening to hold frame in rigid alignment.
  - a. Exposed fastener type; recessed hole at base of jamb for countersunk fastener installation.
  - b. Snap in base anchors
  - c. Strap anchors welded to frame
5. Fire Rating: Supply frame units bearing Labels for fire ratings indicated in Door Schedule for the locations indicated.

## 2.5 HOLLOW METAL FRAMING SYSTEMS

### A. Hollow Metal Framing Systems:

1. Basis of Design: Mesker S-Series, M-Series.
2. Components: Construct architectural stick frame assemblies of standard frame components, fabricated as specified.
  - a. Exterior Frame Material: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M, 14 gauge galvanized steel.
  - b. Interior Frames in Masonry: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M, 16 gauge galvanized steel.
  - c. Interior Frames in stud wall construction: 16 gauge cold rolled steel, ASTM A 1008/A 1008M steel.
  - d. Include galvanized components and internal reinforcements with galvanized frames.
3. Frame component requirements:
  - a. Prepare required sticks at door openings and frame assemblies for hardware as specified in Section 087100.
  - b. Fabricate frame assemblies from three basic components:
    - 1) Open Sections (perimeter members) identical in configuration to standard frames.
    - 2) Closed sections (intermediate members) with identical jamb depth, face dimensions, and stops as open sections.
    - 3) Sill sections: To be flush with both faces of adjacent vertical members. Cut individual components to length and notched to assure square joints and corners.
  - c. Externally welded face joints at meeting mullions or between mullions and other frame members on the face surfaces only. Grind and finish face joints smooth.
  - d. Fabricate frame assemblies for shipment to the jobsite completely welded.
    - 1) Field joints permissible only when the size of the total assembly exceeds shipping limitations.
    - 2) Fabricate oversized frames in sections designated for splicing in the field.
  - e. Pierced and dimpled glazing beads for use with manufacturers' standard fasteners.
  - f. Provide necessary anchors for jambs, heads, and sills of assemblies.

- g. Verify field dimensions as required. Do not begin fabrication until these dimensions have been verified and approved.

4. Accessories:

- a. Glazing Bead: Formed steel sheet; screw-attached.

5. Fire Rating: Provide factory assembled welded units bearing Labels for fire ratings indicated on the Drawings.

## 2.6 ACCESSORIES

- A. Anchors: Manufacturer's standard framing anchors, specified in manufacturer's printed installation instructions for project conditions.
- B. Astragals for pairs of doors: Manufacturer's standard for labeled and non-labeled openings.
- C. Plaster Guards: Same material as door frame, minimum 24-gauge (0.5 mm) minimum; provide for all strike boxes. Plaster guards not mandatory on interior after set frames.
- D. Silencers: Resilient rubber, Inserted type, three per strike jamb for single openings. Stick-on silencers shall not be permitted except on hollow metal framing systems.
- E. Glazing: Specified in Section 088000.

## 2.7 FABRICATION

A. Steel Frames:

- 1. Fabricate steel door and frame units to be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Comply with ANSI/SDI 100 requirements.
  - a. Clearances shall comply with the requirements of NFPA 80.
- 2. Three-piece knock-down frames: Head and jamb intersecting corners die-cut, mitered at 45 degrees, with locking tabs for rigid connection when assembled.
- 3. Factory-welded frames: Head and jamb intersecting corners mitered at 45 degrees, with back welded joints ground smooth.
  - a. Continuous face weld the joint between the head and jamb faces along their length either internally or externally. Grind, prime paint, and finish smooth face joints with no visible face seams.
  - b. Externally weld, grind, prime paint, and finish smooth face joints at meeting mullions or between mullions and other frame members per a current copy of ANSI/SDI A250.8.
- 4. Provide temporary steel spreaders (welded to the jambs at each rabbet of door openings) on welded frames during shipment. Remove temporary steel spreaders prior to installation of the frame.

- B. Tolerances shall comply with SDI-117 "Manufacturing Tolerances for Standard Steel Doors and Frames."
- C. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold-rolled or hot-rolled steel sheet.
- D. Unless otherwise indicated, provide exposed fasteners with countersunk flat or oval heads for

- exposed screws and bolts.
- E. Prepare doors and frames to receive mortised and concealed hardware per final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of SDI-107 and ANSI-A115 Series specifications for door and frame preparation for hardware.
  - F. Reinforce doors and frames to receive surface-applied hardware per SDI A250.6. Drilling and tapping for surface-applied hardware shall be done at Project site. Provide internal reinforcements for all doors to receive door closers and exit devices where scheduled.
  - G. Locate hardware as indicated on Shop Drawings or, if not indicated, per the Door and Hardware Institute's (DHI) "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

## 2.8 FINISHES

- A. Chemical Treatment: Treat steel surfaces to promote paint adhesion.
- B. Exposed door and frame surfaces to be cleaned and treated then coated with rust inhibitive primer. Water-based primer and color paint finishes to be free of Hazardous Air Pollutants (HAPS) and Volatile Organic Compounds (VOCs). Paint to comply with ANSI A250.3 and A250.10.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that project conditions are acceptable before beginning installation of frames.
  - 1. Verify that completed openings to receive knock-down wrap-around frames are of correct size and thickness.
  - 2. Verify that completed concrete or masonry openings to receive butt type frames are of correct size.
- B. Do not begin installation until conditions have been properly prepared.
- C. Correct unacceptable conditions before proceeding with installation.

### 3.2 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's printed installation instructions and with Steel Door Institute's recommended erection instructions for steel frames SDI A250.11 and NAAMM/HMMA 840.
- B. DHI – Door and Hardware Institute – Door Security + Safety Professionals – Installation Guide for Doors and Hardware
- C. Fire Doors and Frames: Install in accordance with SDI A 250.11 and NFPA 80.
  - 1. To ensure compliance with Positive Pressure criteria as required by UBC7-2, UL10C, NFPA5000 and all applicable Local, State and National Code Jurisdictions, all Doors and Frames should be checked for accurate installation per Manufacturers installation instructions to provide proper fire and Smoke Gasketing as tested and listed.
  - 2. Fit hollow-metal doors accurately in frames, within clearances specified in SDI A 250.11 and SDI 100. Install fire rated doors with clearances specified in NFPA 80.
- D. Comply with provisions of SDI-105, “Recommended Erection Instructions for Steel Door Frames,” unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set.

1. Except for frames located in existing concrete, masonry, or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.
  2. In masonry construction, install at least 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors. Use additional anchors as required for height per manufacturers' installation instructions.
  3. At existing concrete or masonry construction, install at least 3 completed opening anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices. Use additional anchors as required for height per manufacturers' installation instructions.
  4. In metal-stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In steel-stud partitions, attach wall anchors to studs with screws. Secure Sill Anchors to floor. Use additional anchors as required for height per manufacturers' installation instructions.
  5. Drywall series frames are designed for installation in interior applications after construction of wood or metal stud and drywall applications. Drywall series frames are provided with adjustable jamb lock anchors for secure installation. Install frames per manufacturers' installation instructions. Adjust anchors and secure sill and baseboard anchors as provided.
- E. Remove temporary steel spreaders prior to installation of frames.
- F. Set frames accurately in position; plumb, align and brace until permanent anchors are set. After wall construction is complete, remove temporary wood spreaders.
1. Field splice only at approved locations indicated on the shop drawings.
  2. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
- G. Provide full height 3/8 inch (9.5 mm) to 1-1/2 inch (38 mm) thick strip of polystyrene foam blocking at frames requiring grouting. Apply the strip to the back of the frame to facilitate field drilling or tapping.
- H. Grouting Hollow Metal Frames:
1. Provide bituminous coating on interior of grout filled jambs.
  2. Provide and install temporary bottom and intermediate wood spreaders to maintain proper width and avoid bowing or deforming of frame members. Refer to ANSI A250.11-2001 and NAAMM/HMMA 840.
  3. Comply with ANSI/SDI Standard A250.8, paragraph 4.2.2, and HMMA 820 TN01 Grouting Hollow Metal Frames, whereby grout will be mixed to provide a 4 inch (102 mm) maximum slump consistency and hand troweled into place. Do not use grout mixed to a thinner consistency.
  4. Provide a vertical wood brace during grouting of frame at openings over 4 foot (1219 mm) wide, to prevent sagging of frame header.
- I. Glaze and seal exterior transom, sidelight and window frames in accordance with HMMA-820 TN03.
- J. Apply hardware in accordance with hardware manufacturers' instructions and Section 087100 of these Specifications. Install hardware with only factory-provided fasteners. Install silencers.

Adjust door installation to provide 1/8" at head and 1/8" at strike and hinge jamb with door undercut to meet fire ratings and floor conditions to achieve maximum operational effectiveness and appearance.

### 3.3 FIELD QUALITY CONTROL

#### A. Fire-Rated Door Assembly Testing:

1. Upon completion of the installation, test each fire door assembly to confirm proper operation of its closing device and verify that it meets all criteria of a fire door assembly per NFPA 80.
2. Perform inspections by individuals with documented knowledge and understanding of the operation components of the type of door being tested per NFPA 80 and NFPA 101.
3. Provide a written record to the Owner with copies available to the Authorities Having Jurisdiction (AHJ).
4. Record shall list the fire door assembly and include the door number with an itemized list of hardware set components for each door opening and location in the facility.

### 3.4 ADJUST AND CLEAN

- A. Adjust doors for proper operation, free from binding or other defects.
- B. Clean and restore soiled surfaces. Remove scraps and debris and leave site in a clean condition.
- C. Prime Coat Touch-Up: Immediately after erection, sand smooth rusted or damaged areas of prime coat, and apply touch-up of compatible air-drying primer.
- D. Properly clean and apply paint to doors and frames in accordance with HMMA-840 TN01 and ANSI A250.8 appendix B along with Manufactures recommended surface preparation for painting.

### 3.5 PROTECTION

- A. Protect installed products and finished surfaces from damage during construction.

END OF SECTION 08 11 13

## SECTION 081416 - FLUSH WOOD DOORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Solid-core doors with wood-veneer faces.
  2. Factory finishing flush wood doors.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of door indicated. Include details of core and edge construction. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
1. Indicate dimensions and locations of mortises and holes for hardware.
  2. Indicate dimensions and locations of cutouts.
  3. Indicate requirements for veneer matching.
  4. Indicate doors to be factory finished and finish requirements.
  5. Indicate fire-protection ratings for fire-rated doors.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
1. Factory finishes applied to actual door face materials, approximately **8 by 10 inches** , for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.
- C. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
- D. Forest Certification: Provide doors made with not less than 70 percent of wood products



obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

#### 1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Warping (bow, cup, or twist) more than **1/4 inch** in a **42-by-84-inch** section.
    - b. Telegraphing of core construction in face veneers exceeding **0.01 inch in a 3-inch** span.
  - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
  - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Graham; an Assa Abloy Group company.
  - 2. Marshfield Door Systems, Inc.
  - 3. VT Industries Inc.

#### 2.2 DOOR CONSTRUCTION, GENERAL

- A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

B. WDMA I.S.1-A Performance Grade: Standard Duty.

C. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-1.
2. Blocking: Provide wood blocking in particleboard-core doors as follows:
  - a. **5-inch** top-rail blocking, in doors indicated to have closers.
  - b. **5-inch** bottom-rail blocking, in doors indicated to have kick plates.

## 2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Custom (Grade A faces).
2. Species: Select White Maple
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Pleasing match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Exposed Vertical Edges: Same species as faces or a compatible species.
7. Core: Structural composite lumber.
8. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.
9. WDMA I.S.1-A Performance Grade: Standard Duty.

## 2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

## 2.5 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory.

C. Transparent Finish:

1. Grade: Premium.
2. Finish: WDMA TR-4 conversion varnish or TR-6 catalyzed polyurethane.
3. Staining: **VT Industries – Onyx, ON18** (Basis of Design)
4. Sheen: Satin.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
  - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Hardware: For installation, see Division 08 Section "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
- C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  - 1. Clearances: Provide **1/8 inch** at heads, jambs, and between pairs of doors. Provide **1/8 inch** from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide **1/4 inch** from bottom of door to top of threshold unless otherwise indicated.
    - a. Comply with NFPA 80 for fire-rated doors.
  - 2. Bevel non-fire-rated doors **1/8 inch in 2 inches** at lock and hinge edges.
  - 3. Bevel fire-rated doors **1/8 inch in 2 inches** at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

### 3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083320 - ROLLING COUNTER DOOR

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rolling Counter Doors, manually operated.

1.2 RELATED SECTIONS

- A. Section 055000 - Metal Fabrications: Support framing and framed opening.
- B. Section 061000 - Rough Carpentry: Wood jamb and head trim.
- C. Section 087100 - Door Hardware: Product Requirements for cylinder core and keys.

1.3 REFERENCES

- A. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM A 666 - Standard Specification for Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
- C. ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- D. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- E. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
- H. NEMA MG 1 - Motors and Generators.

1.4 SUBMITTALS

- A. Submit under provisions of Section 013000.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Details of construction and fabrication.
  - 4. Installation methods.

- C. Shop Drawings: Include detailed plans, elevations, details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent
- D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and patterns.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years' experience in the fabrication and installation of security closures.
- B. Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weathertight location.

#### 1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### 1.8 COORDINATION

- A. Coordinate Work with other operations and installation of adjacent finish materials to avoid damage to installed materials.

#### 1.9 WARRANTY

- A. Warranty: Manufacturer's limited door warranty for 2 years for all parts and components.
- B. PowderGuard Finish.
  - 1. PowderGuard Premium Applied to curtain, guides, bottom bar, headplates: Manufacturer's limited Premium Finish warranty for 2 years.

2. PowderGuard Zinc Base Coat applied to guides, bottom bar, headplates plus PowderGuard Premium applied to curtain and topcoat for guides, bottom bar, headplates: Manufacturer's limited Zinc Finish warranty for 4 years.
3. PowderGuard Textured: Applied to curtain, guides, bottom bar, headplates: Manufacturer's limited Textured Finish warranty for 3 years.
4. PowderGuard Zinc Base Coat applied to guides, bottom bar, headplates plus PowderGuard Textured applied to curtain and topcoat for guides, bottom bar, headplates: Manufacturer's limited Zinc Finish warranty for 4 years.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Overhead Door Corporation, 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067. ASD. Tel. Toll Free: (800) 275-3290. Phone: (469) 549-7100. Fax: (972) 906-1499. Web Site: [www.overheaddoor.com](http://www.overheaddoor.com). E-mail: [info@overheaddoor.com](mailto:info@overheaddoor.com).
- B. Cornell
- C. Clopay
- D. Requests for substitutions will be considered in accordance with provisions of Section 012500 Substitution Procedures

### 2.2 ROLLING METAL COUNTER DOORS WITH INTEGRAL FRAME

- A. Stainless Steel Counter Doors with Integral Frame: Overhead Door Corporation, 657 Series.
  1. Curtain: Interlocking roll-formed stainless-steel slats with a #4 finish and with endlock for curtain alignment. Slats, 22-gauge stainless steel with stainless steel tubular bottom bar with neoprene astragal.
  2. Integral Frame and Sill: Integral stainless-steel frame with a #4 finish and a stainless-steel sill. Frame consists of 16-gauge jambs and header, with 14-gauge sill.
  3. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch (0.8 mm) per foot of span. Counterbalance shall be adjustable by means of an adjusting tension wheel.
  4. Hood: Stainless steel with a #4 finish and provided with intermediate support brackets as required.
  5. Operation:
    - a. Crank operation.

6. Locking:
  - a. Cylinder lock.
7. Wall Mounting Condition:
  - a. Between jambs mounting installed in an existing opening.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify opening sizes, tolerances and conditions are acceptable.
- B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical service with Section 16150. Complete wiring from disconnect to unit components.
- F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.
- G. Install perimeter trim and closures.

#### 3.4 ADJUSTING

- A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Adjust hardware and operating assemblies for smooth and noiseless operation.

### ROLLING COUNTER DOORS

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3.5 CLEANING

- A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.
- B. Remove labels and visible markings.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 PROTECTION

- A. Protect installed products until completion of project.

END OF SECTION



## SECTION 083323 HIGH SPEED ROLL-UP DOORS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. High Performance Exterior High Speed Roll-Up Metal Doors

#### 1.2 RELATED SECTIONS

- A. Section 055000 - Metal Fabrications: Support framing and framed opening.
- B. Section 061000 - Rough Carpentry: Wood jamb and head trim.
- C. Section 08330 [08 33 00] - Coiling Doors and Grilles
- D. Section 087100 - Door Hardware: Product Requirements for cylinder core and keys.
- E. Section 099113 – Exterior Painting: Field applied finish.
- F. Section 16130 [26 05 33] - Raceway and Boxes: Conduit from electric circuit to door operator and from door operator to control station.
- G. Section 16150 [26 05 00] - Common Work Results for Electrical: Power to disconnect.

#### 1.3 REFERENCES

- A. ASTM A 36 - Standard Specification for Carbon Structural Steel.
- B. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- C. ASTM E 283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- D. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- E. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

G. UL Listed - Underwriters Laboratories Inc. Product Listed.

#### 1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. (Basis of Design) High Performance Exterior High Speed Roll-Up Metal Door RapidShield Model 998

1. Wind Load: Design door assembly to withstand ultimate static pressure load of 100 psf (478 Pa) at 15 feet wide, in conformance to ASTM E 330.
2. Impact Rating: Available option with certification for Large Missile Impact Resistance (TAS 201 and 202), with a design pressure of 75psf (359PA) at 16ft wide. This design is approved by the Florida Building Commission, FL #31385.

B. Single-Source Responsibility: Provide doors, guides, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

#### 1.5 SUBMITTALS

A. Submit under provisions of Section 013000.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Details of door materials, construction, and fabrication.
4. Operating characteristics, electrical characteristics, and furnished accessories. Include automatic closing devices and testing and resetting instructions
5. Installation instructions.

C. Shop Drawings: Include detailed plans, elevations, details of framing members, anchoring methods, required clearances, hardware, and accessories. Include relationship with adjacent construction.

D. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors and finishes.

E. Verification Samples: For each finish specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and finishes.

F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

G. Closeout Submittals: Provide manufacturer's maintenance instructions including a detailed parts lists and maintenance recommendations.

## 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of 3 years' experience in the fabrication and installation of security closures.
- B. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum 2 years and approved by manufacturer.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weathertight location.

## 1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

## 1.9 COORDINATION

- A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

## 1.10 WARRANTY

- A. Warranty: Manufacturer's limited door warranty and operator system, except the finish, to be free of defects in material and workmanship for 5 years.

## PART 2 PRODUCTS

## 2.1 MANUFACTURERS

- A. **Basis of Design** Manufacturer: Overhead Door Corporation, 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067. ASD. Tel. Toll Free: (800) 275-3290. Phone: (469) 549-7100. Fax: (972) 906-1499. Web Site: [www.overheaddoor.com](http://www.overheaddoor.com). E-mail: [arcat@overheaddoor.com](mailto:arcat@overheaddoor.com).
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

## 2.2 HIGH PERFORMANCE EXTERIOR HIGH SPEED ROLL-UP METAL DOORS

- A. Model: RapidShield Model 998 high speed roll-up metal door:
1. Performance:
    - a. Opening Speed: Door to operate at a variable speed up to 80 inches (2032 mm) per second (control system dependent).
    - b. Closing Speed: Door to operate at a variable speed up to 20 inches (508 mm) per second.
    - c. Operation Cycles: Drive motor and gearbox capable of operating for not less than 1,000,000 cycles. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
- B. Materials and Components:
1. Door Curtain Design:
    - a. Door Curtain: Double-Walled 6063-T6 Aluminum, 5.8 inch by 1.2 inch thick, with interior face also using 6063-T6 aluminum for the hinge system. Doors that use hinges not made of metal will not be accepted. Door will have UV-Resistant weatherseal between aluminum panel sections.
      - 1) 6063-T6 Aluminum.
      - 2) Finish
        - (a) Silver PowderGuard Premium Powder Coat
        - (b) PowderGuard Premium powder coat, color as selected by Architect.
        - (c) PowderGuard Zinc powder coat, color as selected by Architect.
    - b. Vision Section: 0.125 inch(3.2mm) thick polycarbonate with scratch-resistant coating on both sides.
    - c. Perforated Section: Section 0.125-inch (3.2mm) thick aluminum with 0.25-inch (6.4 mm) diameter perforations 0.375 inch (9.5 mm) on center horizontally, and 0.325inch vertically, staggered rows)

2. Bottom Bar: 6063-T6 Aluminum with integrated wireless sensing edge.
  - a. Finish:
    - 1) **Anodized clear**
  - b. Provide door with a wireless failsafe electric safety edge.
3. Guides: Construct of structural steel, high strength steel cover with structural aluminum track.
  - a. Extend assembly a maximum of 10 inches (254 mm) from the wall.
  - b. Extend assembly width a maximum of 17 inches (432 mm) outward to the side from clear daylight opening.
  - c. Guides have a minimum wall thickness of 3/8 inch for the wall angle and 0.18 inches (4.5 mm) for the cover, to minimize damage if impacted.
  - d. Integrated blanking light curtain channel within the guide. Doors with light curtains mounted outside of the guide will not be accepted. Doors without blanking light curtain will not be accepted.
  - e. Finish:
    - 1) PowderGuard Premium powder coat, color as selected by Architect.
  - f. Door shall have no visible air gaps along the side or top of the door when door panel is in the closed or down position.
  - g. Guides will have weather seal on entire height of door panel.
  - h. Springless System: No springs permitted to assist operation of the door. Guides with enclosed spring must not be accepted due to maintenance, reliability, and life cycle issues.
4. Door Header: Head plates with structural steel truss system spanning the width of the opening. Brackets made of structural Steel and powder coated finish with self-aligning bearings.
  - a. Truss System: Prefabricated structure made of structural steel and powder coated finish.
  - b. Header Door Track: Design that is of concentric circular shape and appropriate spacing to prevent metal to metal contact of slats on each concentric loop for smooth door movement and minimal noise. Doors with header track made of aluminum will not be accepted due to potential strength and fatigue issues for load bearing.
  - c. Brackets: Minimum 1/4 inch (6 mm) thick ASTM A 36 hot rolled steel with heavy-duty, self-aligning bearings with cast iron housings.
  - d. Head frame with a single brush seal along the top of the door.
  - e. Finish:
    - 1) Black PowderGuard Premium powder coat
    - 2) PowderGuard Premium powder coat, color as selected by Architect.
    - 3) PowderGuard Zinc powder coat, color as selected by Architect.
    - 4) PowderGuard Max powder coat, color as selected by Architect.
5. Optional Fascia:
  - a. Finish:

- 1) PowderGuard Premium powder coat, color as selected by Architect.
- b. Material: Galvanized 22-gauge steel
6. Electric Door Operator: UL listed.
  - a. Usage Classification: Heavy duty, rated up to 60 cycles per hour under constant load.
  - b. Motor Exposure: Exterior and Interior use.
  - c. Direct Side Mounted: Operator mounted directly to door drive shaft to the left or right side of the door. No chain and sprocket allowed.
  - d. Electrical Characteristics:
    - 1) Phase and Voltage:
      - (a) 3-Phase 220-240V AC
      - (b) 3-Phase 440-480V AC
      - (c) 3-Phase 575V AC
    - 2) Hertz: 50/60.
  - e. Operator: Minimum 1.0 horsepower. Motor and gearbox designed for high cycle operation with built-in gearbox failure door stop safety device
  - f. Hand Chain: Manual brake disengagement pull switch and hand chain which allows door to be manually opened and closed during a power outage and installation.
  - g. Limit System: Magnetic type providing absolute positioning with push to set and remote setting capabilities. Limit system shall remain synchronized with the door during manual operation and supply power interruptions.
  - h. Timer to Close: Each door to have automatic closing controlled by an adjustable hold open time delay.
7. Control System:
  - a. Microprocessor based with variable frequency drive controller, capable of variable speed control in both up and down directions. System incorporates a Liquid Crystal Display (LCD) to display the system status.
  - b. Capable of monitoring and reporting on a variety of operating conditions, including: Current operating status, Current command status, Current error status (if applicable), Hoist interlock status (if applicable), Service reminder status, and 24VDC status.
  - c. Control system is housed in a NEMA 4X panel with built-in push buttons and main power padlock-able rotary disconnect switch.
8. Activation Devices: Provide for condition of exposure and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.
  - a. Pedestrian Type Activation Devices:
    - 1) Single Push Button Switch: Push to open, timer to close.

- 2) Palm Push Button Switch: Large type push button - push to open, timer to close.
  - 3) Three Push Button Switch: Button for open, button for close, button for stop.
  - 4) Pull Cord: Pull to open - Timer to Close.
  - 5) Pull Cord: Pull to Open – Pull to Close.
  - 6) Motion Sensor: BEA Falcon, BEA LZR WIDESCAN, microwave scanner, field adjustable wide angle.
    - (a) Differentiates between pedestrian and vehicular traffic.
    - (b) Prevents false activation from cross traffic,
    - (c) Remote control for set-up.
- b. Vehicular Type Activation Devices:
- 1) Motion Sensor: BEA Falcon, BEA LZR WIDESCAN, microwave scanner, field adjustable wide angle.
    - (a) Differentiates between pedestrian and vehicular traffic.
    - (b) Prevents false activation from cross traffic,
    - (c) Remote control for set-up.
  - 2) Loop Detector: Detects ferrous metal objects via an inductive field for activation. Requires a channel to be cut into floor to install inductive loop wire.
  - 3) Pull Cord: Pull to open - Timer to Close.
  - 4) Pull Cord: Pull to Open – Pull to Close.
  - 5) Radio Control Activation: Near proximity portable push button remote control programmable to individual doors or multiple doors in common.
    - (a) One Button Remote Control.
    - (b) Four Button Remote Control.
9. Safety Devices: Provide for condition of exposure and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated. Coordinate safety devices with door operation and door operator mechanisms.
- a. Door provided with blanking light curtain located in plane to the travelling path of the door curtain. Doors with light curtain mounted to the exterior of the guide will not be accepted.
  - b. Door provided with monitored failsafe electric safety edge. Controller must indicate if the safety edge is not operable.
    - 1) Connections between safety edge and controller shall be fully wireless. No coil cords allowed.
    - 2) Bottom bar wireless system battery must be able to be replaced at ground level.
  - c. Belt Tension Sensor provided with monitored communication. Doors that operate door with any type of belt or system must have tension monitoring or will not be accepted.
  - d. Optional Photo eyes may be provided and will be integrated within the guide cover.

10. Finish Requirements:
  - a. Galvanized Steel: Hood galvanized in accordance with ASTM A 653 and receive rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on black polyester topcoat.
  - b. PowderGuard powder coat: Guides, Truss and brackets shall be powder coated with weather and corrosion resistant polyester powder coat.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify opening sizes, tolerances and conditions are acceptable.
- B. Verify site electrical characteristics and supplies.
- C. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.



- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical service with Section 16150. Complete wiring from disconnect to unit components.
- F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.
- G. Install perimeter trim and closures.
- H. Instruct Owner's personnel in proper operating procedures and maintenance schedule.

#### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

#### 3.5 ADJUSTING

- A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Adjust hardware and operating assemblies for smooth and noiseless operation.
- C. Adjust seals to provide tight fit around entire perimeter.

#### 3.6 CLEANING

- A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.

- B. Remove labels and visible markings.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain high speed roll-up doors.

### 3.8 PROTECTION

- A. Protect installed products until completion of project.

### 3.9 SCHEDULES

- A. SEE DOOR SCHEDULES FOR FIRE STATION & PUBLIC WORKS BUILDING.

END OF SECTION

083514 HURRICANE RATED FOUR-FOLD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes Four-Fold metal doors, tested, and approved for High Velocity Hurricane Zones, up to 120psf and approved by Florida Building Code, **#FL32280 Level-E, #FL17136 Level-D**.
- B. Operation of Four-Fold metal doors includes overhead mounted electro-mechanical operators.
- C. Doors tested and approved for up to 16'-0"x16'-0" openings, consult manufacturer for larger openings.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified consisting of manufacturer's technical Product Data and installation instructions for each type of door required, including data substantiating that products comply with requirements.
- C. Submittal Drawings showing fabrication and installation of Four-Fold metal doors including plans, elevations, sections, details of components, hardware, operating mechanism, and attachments to the other units of Work. Include wiring diagrams for coordination with electrical trade.
- D. Reference list including (5) successful installations of this type of hurricane rated doors within the past two (2) years.

1.4 QUALITY ASSURANCE

- A. Doors shall be designed to withstand external or internal horizontal wind loads of 120 pounds minimum per square foot. The maximum allowable deflection shall not exceed 1/120 of the span. Fiber stresses in main members shall be limited to 27,000 pounds per square inch. Steel frames shall be designed in accordance with the AISC "Steel Construction Manual".

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store delivered materials and equipment in dry locations with adequate ventilation, free from dust and water, and so as to permit access for inspection and handling.
- B. Handle materials carefully to prevent damage.

## 1.6 WARRANTY

- A. The door manufacturer shall provide a written standard limited warranty for material and workmanship.

## PART 2 – PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Four-Fold industrial metal doors manufactured by Door Engineering and Manufacturing, 101 Power Dr, Mankato, MN 56001, (800)-959-1352. Equal products by other manufacturers approved in advance, including State of Florida (FBC) approval.

### 2.2 MATERIALS

- A. Steel Tube: ASTM A513 and ASTM A500/A500M
- B. Steel Sheets: Steel sheets of commercial quality, complying with ASTM A1008 cold-rolled steel sheet.
- C. Hardware: Manufacturer's standard components.
- D. Fasteners: Zinc-coated steel.

### 2.3 FOUR-FOLD DOORS

- A. Basis-of-Design Product: The drawings and specifications are based on the FF701 Series, Glazed or Solid Sheeted Four-Fold Doors as manufactured by Door Engineering and Manufacturing, LLC; Mankato, MN.
- B. Construction: Door framing shall be minimum 11-gauge structural steel tube with 14-gauge sheet steel on the exterior and interior faces. Sheeting shall be formed on the vertical edges with no visible welds or caulked sheet edges on the interior or exterior panel faces. All frames and framing members shall be true to dimension and square in all directions, and no door shall be bowed, warped, or out of line, in the vertical or horizontal plane of the door opening by more than 1/8 inch in 20 feet. Exposed welds and welds which interfere with the installation of various parts shall be ground smooth and flush.
- C. Surface Mounted Tube Frame: Supply pre-hung tube frame system constructed of TS6x6x0.25", designed to anchor to masonry wall construction or weld to steel structure. All hinges, track supports, and operator supports shall be factory attached.
- D. Factory finish: Operator and operating hardware shall be powder-coated manufacturer's standard gray. Panels, frame, and all other hardware shall be finished as follows:

- a. All exposed steel shall be finished with manufacturer's standard zinc rich primer and polyurethane top-coat, PPG Spectracron or equal. Customer to select from Manufacturer's standard color chart or furnish color to match.
- E. Operating Hardware: Hardware shall include guide tracks and brackets, trolleys, center guides, not less than three pairs of jamb and fold hinges per opening, and all bolts, nuts, fasteners, etc. necessary for complete installation and operation. Jamb hinges shall be dual shear and have two thrust bearings and two needle bearings. Jamb hinges shall be gusseted. Fold hinges shall be dual shear with two thrust bearings. Fold hinges shall be stainless steel. All bearings shall be completely sealed within the hinge barrel and include grease zerks. All hinge pins shall be minimum 3/4" diameter hardened steel. All trolleys shall be equipped two (2) Nylatron rollers.
- F. Hinge Guards: Provide plastic guards at jamb hinges to prevent access through hinge space.
- G. Weatherstripping: Material shall be adjustable and readily replaceable and provide a substantially weather-tight installation. Weatherstripping at center shall be 1/16" cloth inserted neoprene. No exposed fasteners shall be required to attach the center bulb weatherseals. Weatherstripping at sill shall include two 1/16" cloth inserted neoprene sweeps with an aluminum retainer. The retainer shall be attached to the door with adhesive.
- H. Perimeter Weatherstripping: Provide jamb and head weather-stripping of 1/16" cloth-inserted neoprene bulb (or closed cell neoprene).
- I. Vision Panels:
  - a. Level D: 1-1/4" Impact rated glazing
- J. Hurricane Locking System: Locking bolts shall be completely concealed within the door panel. Locking bolts shall extend into the floor and into the header tube. A limit switch shall disable the operator when the locks are engaged.

## 2.4 OPERATOR

- A. Each Four-Fold door shall be operated by an overhead mounted electro-mechanical drive unit designed for high cycle operation. Operator consists of an electric motor, gear reducer, and rotating drive arm. The door shall be operated with connecting rods attached to the rotating drive arm on the operator and to control arms attached to the jamb door section and to the door lintel. The connecting rods shall be positive drive, keeping the door under firm control at all times. The connecting rods shall be fitted with spherical bearings and control arms shall be equipped with oil impregnated bronze bearings on polished shafts.
- B. Operator shall be instantly reversible, open and close rapidly and start and stop gradually. Operator shall be adjustable to allow door to fully clear the opening. Operator shall automatically lock the door in the closed position. Operator shall be equipped with disengaging mechanism to convert to manual operation.
- C. Electric motor shall be of sufficient size to operate doors under normal operating conditions at no more than 75 percent of rated capacity. The motor shall be wound for three phase 208/260/480 VAC, 60 Hertz operation.

- D. Electric Controls: Controls shall be furnished by the door manufacturer and shall be complete for each door and built-in accordance with the latest NEMA standards. Incoming electrical shall be 208/230VAC 3-phase.
1. Control panel assemblies shall be UL listed as per NFPA70.
  2. Controls shall include a programmable logic controller with digital message display. Controller shall include programmable close timers and programmable inputs/outputs
  3. Motor starters shall be magnetic reversing, factory wired with overload and under voltage protection, and equipped with mechanical interlocks. All control components shall be enclosed in one enclosure with a wiring diagram placed on the inside of the cover.
  4. If incoming voltage is single phase, control panel shall include a variable frequency drive to convert voltage to 3-phase for the motor
  5. Enclosures shall be NEMA 4 with disconnect switch.
  6. Pushbuttons (interior) for each door shall have one momentary pressure three-button push-button station marked "OPEN", "CLOSE" and "STOP". Push button enclosure shall be NEMA 4.
  7. Limit switches shall be provided to stop the travel of the door in its fully open or fully closed position. Provide cremone bolt limit switch to be used for HVAC or exhaust removal system.
  8. Safety edges: Provide monitored electric safety edges on leading edge of all doors to reverse door upon contact with obstruction.
  9. Photo eyes: Provide (1) exterior, jamb mounted, light Curtain type photo eyes, NEMA 4 rated. Photo eye shall cover from floor level to 72" above floor.
  10. Presence Sensor: Provide (1) interior, overhead mounted, presence sensor BEA IS40P or equal. Doors over 16' tall shall include LZR-Widescan or equal.
  11. (Option) Radio controls: Provide one (1) radio receiver and (1) single button remotes per door. Remotes to open and close doors with single button.
  12. (Option) Timer Activation Loop Detectors (**fire station applications**): Provide "pulse on exit type" loop detector to activate auto close timer once loop has been activated and cleared, include hand/auto switch to deactivate timer. G.C. to coordinate installation of preformed loop with installer prior to exterior apron being poured.
  13. (Option) Warning Horn/Strobe: Provide warning light and strobe. Include outputs PLC to allow for activation while door is in motion both opening and closing, along with activation prior to closing. Include programmable "delay-to-close" timer which activates the warning horn for a set time, prior to the door closing.

14. Wiring: Door manufacturer shall supply controls and components only. Electrical contractor shall install controls and furnish and install conduits and wiring for jobsite power and control wiring.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install Four-Fold metal doors in strict accordance with the approved drawings by qualified door erection crews. All door openings shall be completely prepared by the general contractor prior to the installation of the doors. Permanent or temporary electric wiring shall be brought to the door opening before installation is started and shall be completed so as not to delay the inspection test.
- B. Doors shall be set plumb, level, and square, and with all parts properly fastened and mounted. All moving parts shall be tested and adjusted and left in good operating condition.

#### 3.2 ADJUSTING AND CLEANING

- A. Inspection of the doors and a complete operating test will be made by the installer in the presence of the general contractor or architect as soon as the erection is complete. Any defects noted shall be corrected. After door approval in the above test, the general contractor must assume the responsibility for any damage or rough handling of the doors during construction until the building is turned over to the owner and final inspection is made.
- B. Clean surfaces and repaint abraded or damaged finished surfaces to match factory-applied finish.

END OF SECTION

## SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Exterior and interior storefront framing.
2. Storefront framing for punched openings.
3. Exterior and interior manual-swing entrance doors and door-frame units.

#### 1.2 PERFORMANCE REQUIREMENTS

##### A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
2. Dimensional tolerances of building frame and other adjacent construction.
3. Failure includes the following:
  - a. Deflection exceeding specified limits.
  - b. Thermal stresses transferring to building structure.
  - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
  - d. Noise or vibration created by wind and by thermal and structural movements.
  - e. Loosening or weakening of fasteners, attachments, and other components.
  - f. Sealant failure.
  - g. Failure of operating units.

##### B. Structural Loads:

1. Wind Loads: As indicated on Structural Drawings.

##### C. Deflection of Framing Members:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed  $L/175$  of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to  $3/4$  inch (19 mm), whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to  $L/360$  of clear span or  $1/8$  inch (3.2 mm), whichever is smaller.

##### D. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:



1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
  2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
  3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.
- E. Windborne-Debris-Impact Resistance Performance: Shall be tested in accordance with ASTM E 1886, information in ASTM E 1996 and TAS 201/203.
1. Large-Missile Impact: For aluminum-framed systems located within 30 feet (9.1 m) of grade.
  2. Small-Missile Impact: For aluminum-framed systems located above 30 feet (9.1 m) of grade.
- F. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa).
- G. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- H. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
  2. Interior Ambient-Air Temperature: 75 deg F (24 deg C).
- I. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 53 when tested according to AAMA 1503.
- J. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K) when tested according to AAMA 1503.
- 1.3 SUBMITTALS
- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.
  - B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
2. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.
- D. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.
- E. Warranties: Sample of special warranties.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- D. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
- E. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

#### 1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration caused by thermal movements.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    - d. Water leakage through fixed glazing and framing areas.
    - e. Failure of operating components.
  2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
1. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Kawneer North America; an Alcoa company.
  2. Oldcastle.

### 2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
  2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
  3. Extruded Structural Pipe and Tubes: ASTM B 429.
  4. Structural Profiles: ASTM B 308/B 308M.
- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.

### 2.3 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides.
  3. Glazing Plane: As indicated.
- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard stainless steel fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  2. Reinforce members as required to receive fastener threads.
  3. No exposed fasteners will be permitted.
- D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.
- E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

## 2.5 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
1. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) hick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
  2. Door Design: Wide stile; 5-inch (127-mm) nominal width.
    - a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.

3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
  - a. Provide nonremovable glazing stops on outside of door.

## 2.6 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."
  1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.
- C. Flashing Pan: Manufacturer's standard window sill flashing pan with end dams.

## 2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
  1. Profiles that are sharp, straight, and free of defects or deformations.
  2. Accurately fitted joints with ends coped or mitered.
  3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
  4. Physical and thermal isolation of glazing from framing members.
  5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  6. Provisions for field replacement of glazing from interior.
  7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Storefront Framing: Fabricate components for assembly using shear-block system or screw-spline system.
- D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
  1. At exterior doors, provide compression weather stripping at fixed stops.
  2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

- E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
  - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General:
  - 1. Comply with manufacturer's written instructions.
  - 2. Do not install damaged components.
  - 3. Fit joints to produce hairline joints free of burrs and distortion.
  - 4. Rigidly secure nonmovement joints.
  - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
  - 6. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
  - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
  - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

- E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.
- F. Install glazing as specified in Division 08 Section "Glazing."
- G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
  - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
  - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- H. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

### 3.3 ERECTION TOLERANCES

- A. Install aluminum-framed systems to comply with the following maximum erection tolerances:
  - 1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
  - 2. Alignment:
    - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
    - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).
- B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).

### 3.4 ADJUSTING

- A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
  - 1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches (75 mm) from the latch, measured to the leading door edge.

END OF SECTION 084113

## SECTION 084423 - GLAZED ALUMINUM CURTAIN WALLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Conventionally glazed aluminum curtain walls.

##### B. Related Requirements:

1. Section 079200 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
2. Section 088000 "Glazing" for curtain wall glazing.

#### 1.2 PREINSTALLATION MEETINGS

- ##### A. Preinstallation Conference: Conduct conference at Project site.

#### 1.3 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

##### B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
3. Product Certificates: For materials manufactured within 100 miles (160 km) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.
4. Environmental Product Declaration: For each product.
5. Health Product Declaration: For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

##### C. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.



2. Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
    - a. Joinery, including concealed welds.
    - b. Anchorage.
    - c. Expansion provisions.
    - d. Glazing.
    - e. Flashing and drainage.
  3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Delegated-Design Submittal: For glazed aluminum curtain walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
1. For Installer.
  2. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the state in which Project is located.
- B. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
- C. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
- D. Sample Warranties: For special warranties.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and acceptable to Owner and Architect.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

## 1.7 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Build mockup of typical wall area as shown on Drawings.
  - 2. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.8 WARRANTY

- A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration created by wind and thermal and structural movements.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    - d. Water penetration through fixed glazing and framing areas.
    - e. Failure of operating components.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 20 years from date of Substantial Completion.
- C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, peeling, or chipping.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed aluminum curtain walls.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  - 2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
  2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
  2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
    - a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
  3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
    - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4-inch (6.35-mm) for spans of greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans of less than 11 feet 8-1/4 inches (3.6 m).
- E. Structural: Test according to ASTM E 330/E 330M as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
- F. Windborne-Debris-Impact-Resistance Performance: Shall be tested in accordance with ASTM E 1886 and information in ASTM E 1996 and TAS 201/203.
1. Large-Missile Impact: For aluminum-framed systems located within 30 feet (9.1 m) of grade.
  2. Small-Missile Impact: For aluminum-framed systems located above 30 feet (9.1 m) of grade.
- G. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
    - a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) .
- H. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- I. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
  2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.
- J. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system shall have U-factor of not more than 0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K) as determined according to NFRC 100.
  2. Condensation Resistance: Fixed glazing and framing areas as a system shall have an NFRC-certified condensation resistance rating of no less than 29 as determined according to NFRC 500.
- K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
  2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
    - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
    - b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

## 2.2 SOURCE LIMITATIONS

- A. Obtain all components of curtain-wall system and storefront system, including framing spandrel panels entrances and accessories, from single manufacturer.

## 2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Kawneer North America, an Arconic company.
  2. Oldcastle, Inc.
- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
  1. Construction: Thermally broken.
  2. Glazing System: Retained mechanically with gaskets on four sides.
  3. Glazing Plane: Front.
  4. Finish: Clear anodic finish .

5. Fabrication Method: Either factory- or field-fabricated system.
  6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  7. Steel Reinforcement: As required by manufacturer.
- C. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
1. Include snap-on aluminum trim that conceals fasteners.
- D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- E. Glazing: As specified in Section 088000 "Glazing".
- F. Entrance Door Systems: Comply with Section 084113 "Aluminum-Framed Entrances and Storefronts".

## 2.4 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: ASTM C 509 or ASTM C 864. Extruded silicone.
1. Color: Black.
- C. Glazing Sealants: As recommended by manufacturer.
1. Sealant shall have a VOC content of 250 g/L or less.
- D. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.

## 2.5 MATERIALS

- A. Sheet and Plate: ASTM B 209 (ASTM B 209M).
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
- C. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
- D. Structural Profiles: ASTM B 308/B 308M.
- E. Steel Reinforcement:
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
  2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
  3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

- F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
- G. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site.

## 2.6 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  - 2. Reinforce members as required to receive fastener threads.
  - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
  - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

## 2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
  - 1. Profiles that are sharp, straight, and free of defects or deformations.
  - 2. Accurately fitted joints with ends coped or mitered.
  - 3. Physical and thermal isolation of glazing from framing members.
  - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 5. Provisions for field replacement of glazing from exterior.
  - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest

- extent possible.
7. Components curved to indicated radii.
- D. Fabricate components to resist water penetration as follows:
1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
  2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
- E. Curtain-Wall Framing: Fabricate components for assembly using shear-block system.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

### 3.3 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.



- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
- G. Seal joints watertight unless otherwise indicated.
- H. Metal Protection:
  - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
  - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- J. Install components plumb and true in alignment with established lines and grades.

### 3.4 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 088000 "Glazing."
  - 1. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

### 3.5 INSTALLATION OF WEATHERSEAL SEALANT

- A. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

### 3.6 ERECTION TOLERANCES

- A. Install glazed aluminum curtain walls to comply with the following maximum tolerances:
  - 1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
  - 2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
  - 3. Alignment:
    - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
    - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
    - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm)

wide or more, limit offset from true alignment to 1/4 inch (6 mm).

4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.
- C. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.
  1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    - a. Perform a minimum of two tests in areas as directed by Architect.
  2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
    - a. Perform a minimum of two tests in areas as directed by Architect.
  3. Water Penetration: ASTM E 1105 at a minimum uniform static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
- D. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 084423

## SECTION 08 56 59 SERVICE AND TELLER WINDOW UNITS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Fully-Automatic pass, service and teller window units – (Exterior unit).
  2. Bullet resistant pass, service and teller window units – (Interior units).
  3. Drawers.
  4. Glazing.
- B. Related Sections:
1. Section 042200 – Reinforced Unit Masonry, 042113 Brick Veneer Masonry & 047200 Cast Stone Masonry: Exterior wall construction.
  2. Section 054000 - Cold Formed metal Framing: Partition construction.
  3. Section 061000 - Rough Carpentry: Partition construction.
  4. Section 076200 - Sheet Metal Flashing and Trim
  5. Section 079200 - Joint Sealants.
  6. Section 084113 - Aluminum-Framed Entrances and Storefronts
  7. Section 092216 – Non-Structural Metal Framing
  8. Section 092900 - Gypsum Board Assemblies: Partition construction
  9. Electrical requirements Division 26.

#### 1.2 REFERENCES

- A. American Architectural Manufacturers Association:
1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
  2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
- B. American Society Mechanical Engineers Standards:
1. ASME SA-240/SA-240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- C. ASTM International:
1. ASTM A27/A27M - Standard Specification for Steel Castings, Carbon, for General Application.
  2. ASTM A 36/A 36M. - Standard Specification for Carbon Structural Steel.
  3. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
  4. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  5. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  6. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
  7. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

8. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
  9. ASTM B221/B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  10. ASTM C1036 - Standard Specification for Flat Glass.
  11. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
  12. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
  13. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics.
  14. ASTM E488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
  15. ASTM E699 - Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
  16. ASTM E2188 - Standard Test Method for Insulating Glass Unit Performance.
  17. ASTM E2189 - Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units.
  18. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.
  19. ASTM F588 - Standard Test Methods for Resistance of Window Assemblies to Forced Entry Excluding Glazing.
  20. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
- D. California Model Building Security Ordinance:
1. CMBSO - Section 15.52.100, Tests CAWM 301-90, Forced Entry Resistance Tests for Windows.
- E. Consumer Products Safety Commission:
1. CPSC 16 CFR 1201 - Safety Standard for Architectural Glazing.
- F. CSA International - Canadian Standards Association:
1. CAN/CSA C22.2 No. 68-92 - Motor-Operated Appliances (Household and Commercial).
  2. CAN/CSA C22.2 No. 247 - Operators and Systems of Doors, Gates, Draperies and Louvers.
- G. DuPont Powder Coating Test Method:
1. DPC TM 10.219 - PCI Powder Smoothness.
- H. Florida Building Code:
1. See Miami-Dade County below.
- I. H.P. White Laboratory, Inc.:
1. HPW-TP0500.01:
    - a. Level V.
    - b. Level C Ballistics (.44 magnum).
  2. HPW-TP-0500.02 - Level B Ballistics (9mm).

- J. Miami-Dade County:
  - 1. Air Infiltration Test, per FBC, TAS 202-94
  - 2. Uniform Static Air Pressure Test, Loading per FBC, TAS 202-94
  - 3. Water Resistance Test, per FBC, TAS 202-94
  - 4. Large Missile Impact Test per FBC, TAS 210-94
  - 5. Cyclic Wind Pressure Loading per FBC, TAS 203-94
  - 6. Forced Entry Test, per FBC 2411 3.2.1, TAS 202-94
  
- K. National Association of Architectural Metal Manufacturers.
  - 1. NAAMM No. 3 Finish: Ground unidirectional uniform finish obtained with 80 - 100 grit abrasive.
  
- L. SAE International:
  - 1. AMS5511 - Steel, Corrosion-Resistant, Sheet, Strip, and Plate, 19Cr - 9.5Ni (304L), Solution Heat Treated.
  - 2. AMS5513 - Steel, Corrosion-Resistant, Sheet, Strip, and Plate 19cr 9.2Ni (SAE 30304) Solution Heat Treated.
  
- M. Steel Structures Painting Council:
  - 1. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
  
- N. Underwriters Laboratory:
  - 1. UL 73 - Motor-Operated Appliances.
  - 2. UL 325 - Door, Drapery, Gate, Louver, and Window Operators and Systems.
  - 3. UL 752 - Ballistic Standards:
    - a. Level I MPSA 9mm.
    - b. Level III SPSA .44 Magnum.
  - 4. UL 1995 - Heating and Cooling Equipment.

### 1.3 PERFORMANCE REQUIREMENTS

- A. System Design: Design and size components to withstand dead loads and live loads caused by pressure and negative wind loads acting normal to plane of window as calculated in accordance with applicable code.
  
- B. System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, and migrating moisture occurring within system, to exterior by weep drainage network.
  
- C. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with [inside] pane of glass and heel bead of glazing compound. [Position thermal insulation on exterior surface of air barrier and vapor retarder.]
  
- D. Ballistics-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
  - 1. Listed and labeled as bullet resisting according to UL 752.

- E. Forced-Entry-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
  - 1. Tested for forced-entry resistance according to ASTM F588 [\_\_\_\_\_] by a testing agency acceptable to authorities having jurisdiction.
- F. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
  - 1. To utilize the inner pane of multiple pane sealed units for the continuity of the air barrier and vapor retarder seal.
- G. Structural Design: Design glass and glazing in accordance with Florida Building code for most critical combination of wind, snow, seismic, and dead loads.
- H. Electrical Requirements:
  - 1. Motor operated to comply with CAN/CSA C22.2 No. 68-92 and UL 73.
  - 2. Operators and systems for doors, gates, and window operators to comply with CAN/CSA C22.2 No. 247 and UL 325.
- I. Heating and cooling type equipment to comply with UL 1995.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures {01330 - Submittal Procedures}: Requirements for submittals.
- B. Shop Drawings:
  - 1. Indicate configuration, sizes, rough-in, mounting, construction and glazing details as well as installation clearances and finishes.
- C. Product Data:
  - 1. Submit manufacturer's product data for specified Products indicating materials, operation characteristics, and finishes.
- D. Samples:
  - 1. Submit two samples, 4 x 4 inches (100 x 100 mm) in size illustrating metal finishes for each finish specified.
- E. Test Reports:
  - 1. [Indicate compliance with specified bullet resistance performance.]
- F. Manufacturer's Installation Instructions:
  - 1. Submit installation instructions with requirements to accommodate specific site conditions.

#### 1.5 QUALITY ASSURANCE

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum 10 years documented experience.

1. Participates in a Quality Assurance validation Program.
  - a. Facility Audit.
- B. Installer: Company specializing in installation of window systems specified with minimum three years documented experience.

#### 1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Section 01 60 00 - Product Requirements {01600 - Product Requirements}: Requirements for transporting, handling, storing, and protecting products.
- B. Ordering: To avoid construction delays comply with ordering instructions and lead time requirements as set by window system manufacturer.
- C. Pack window units and accessories in manufacturer's standard shipping containers and protective packaging. Deliver units in manufacturer's original packaging and unopened containers with identification labels intact.
- D. Store window units and accessories on raised blocks to prevent moisture damage protected from exposure to weather and vandalism.

#### 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication and record on shop drawings.

#### 1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements {01300 - Administrative Requirements}: Requirements for coordination.
- B. Coordinate work with adjacent materials specified in other Sections and as indicated on Drawings and approved shop drawings.
- C. Coordinate installation of anchorages for security windows. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in [concrete] [or] [masonry]. Deliver such items to Project site in time for installation.

#### 1.10 WARRANTY

- A. Furnish manufacturer's standard warranty document, executed by an authorized Quikserv Corp. officer in which manufacturer agrees to repair or replace windows, drawers and air curtains that fail in materials or workmanship within specified warranty period. This warranty is in addition to, and not a limitation of other rights Owner has under the contract.
  1. Warranty Period:
    - a. One year parts and labor from date of installation.
  2. Failures include, but are not limited to, the following:
    - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

- b. Structural failures including deflections exceeding 1/4 inch.
- c. Failure of welds.
- d. Excessive air leakage.
- e. Faulty operation of sliding window hardware.
- f. Faulty operation of transaction drawers.
- g. Faulty operation of air curtains.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B221/B221M. Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength and not less than 0.125 inch (3.2 mm) thick at any location for main frame and sash members.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Metallic-Coated Steel Sheet:
  - 1. ASTM A653/A653M, CS (Commercial Steel), Type B; with G90 (Z275)zinc (galvanized) coating designation.
  - 2. AMS5511, steel, corrosion-resistant, sheet, strip, and plate, 19Cr - 9.5Ni (304L), solution heat treated.
  - 3. AMS5513, steel, corrosion-resistant, sheet, strip, and plate 19cr 9.2Ni (SAE 30304) solution heat treated.
- D. Stainless Steel Sheet, Strip, Plate, and Flat Bars:
  - 1. ASTM A666, austenitic stainless steel, Type 304, stretcher-leveled standard of flatness.
  - 2. ASME SA-240/SA-240M, chromium and chromium-nickel stainless steel plate, sheet, and strip for general applications.
- E. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.
- F. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to [four] [\_\_\_\_] times the load imposed, as determined by testing per ASTM E488, conducted by a qualified testing agency.
  - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A27/A27M cast steel or ASTM A47/A47M malleable iron. Provide bolts, washers, and shims as required; hot-dip galvanized per ASTM A153/A153M or ASTM F2329.
- G. Embedded Plate Anchors: Fabricated from steel shapes and plates, minimum 3/16 inch (4.8 mm) thick; with minimum 1/2-inch- (12.7-mm-) diameter, headed studs welded to back of plate..
- H. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.



- I. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.76-mm) thickness per coat.
- J. Sealants: For sealants required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating.
- K. Gaskets: For gaskets required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Gaskets shall remain permanently elastic, nonshrinking, and nonmigrating.

## 2.2 WINDOW COMPONENTS

- A. Comply with requirements of UL listing for ballistics-resistance levels as specified.
- B. Glass:
  - 1. Tempered Glass: 1/4 inch thick.
  - 2. Insulated Glass: 5/8 inch thick overall thickness.
- C. Bullet Resistant Glazing:
  - 1. Model QSBR - Sheet:
    - a. LEXGARD® MP750 Level 1 - 9mm or .38 Special caliber rated.
    - b. SPARTECH POLYCAST MP 1.25 Level 1- 9mm or .38 Special caliber rated.
    - c. LEXGARD® SP1250 Level 3 - .44 Magnum caliber rated.
- D. Track/Slides: Stainless steel ball bearing slides all windows and drawers.
- E. Miscellaneous Glazing Materials: Provide material, size, and shape complying with requirements of glass manufacturers, and with a proven record of compatibility with surfaces contacted in installation:
  - 1. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
  - 2. Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.
  - 3. Spacers: Elastomeric blocks or continuous extrusions with a Type A Shore durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
  - 4. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Flashing.
- G. Welding Materials.
- H. Anchors, Clips, and Window Accessories: Stainless steel; hot-dip, zinc-coated steel or iron, of sufficient strength to withstand design pressure indicated.

## 2.3 FULLY-AUTOMATIC PASS, SERVICE AND TELLER WINDOW UNITS

### A. Manufacturers:

1. Quikserv Corp. (Basis of Design)
  - a. Model BP-7241E (Bi-Parting Horizontal Sliding Window Unit):
    - 1) Service Opening: 29-1/2 inches (w) x 32 inches (h).
    - 2) Rough Opening: 72-1/2 inches (w) x 41-1/2 inches (h).
    - 3) Operating Sensor:
      - a) Thru-Beam Horizontal Eye Bar.
      - b) Push Button.
    - 4) Glazing:
      - a) Level 1 Bullet Resistant.
      - b) 5/8 inch insulated.
      - c) 1/4 inch tempered.
    - 5) Finish: [Bronze.] [Clear.] [Custom Color.]
    - 6) Meets Performance Requirements of CMBSO, Section 15 52 100, Tests CAWM 301-90, Forced Entry Resistance Test for Windows, and ASTM F588.
  - b. Model BP-7241E IP (Bi-Parting Horizontal Impact Slider)
    - 1) Service Opening: 27 inches (w) x 27 inches (h).
    - 2) Rough Opening: 72 1/2 inches (w) x 41 1/2 inches (h).
    - 3) Miami-Dade NOA # 13-0822.06
    - 4) Florida Building Code # FL-16711

## 2.4 BULLET RESISTANT PASS, SERVICE AND TELLER WINDOW UNITS & PACKAGE RECEIVER UNITS

### A. Manufacturers:

1. Quikserv Corp. (Basis of Design)
  - a. Model T1 - 3636S:
    - 1) Rough Opening: 36-3/8 inches (w) x 36-3/8 inches (h). [Custom size as indicated on Drawings plus 3/8 inch on all sides.]
    - 2) Glazing:
      - a) Level 1 Bullet Resistant.
      - b) 1/4 inch tempered.
    - 3) Finish: to be selected from the manufacturer's standard range.
      - a) UL Rated Level 3 framing available

## 2.5 GLAZING

### A. Float Glass Materials:

1. Annealed Glass: ASTM C1036, Type 1 transparent flat, Quality Q3, float glass.
  - a. Furnish annealed glass except where tempered glass is required to meet specified performance requirements.
2. Tempered Glass: ASTM C1048, Type 1 transparent flat, Quality Q3, Kind FT fully tempered, Condition A uncoated, float glass with horizontal tempering.

- a. Fabricate tempered glass with roller-wave distortion parallel to bottom edge of glass as installed.
  - b. Furnish tempered glass conforming to CPSC 16 CFR 1201 Category II.
- B. Clear Glass: Annealed and Tempered float glass as specified; Class 1 clear.
1. Clear annealed glass (FG-CA).
  2. Clear tempered glass (FG-CT).
  3. Minimum Thickness: 1/4 inch.
- C. Tinted Glass: Tempered float glass as specified; Class 2 tinted.
1. Tinted tempered glass (FG-TT).
  2. Minimum Thickness: 1/4 inch.
  3. Tint: Tint color as indicated on Drawings, if not indicated on Drawings as selected by Architect.
- D. Low E Glass: Tempered float glass as specified; [[Class 1 clear.] [Class 2 tinted.]]
1. Clear Low E tempered glass (FG-ECT).
  2. Tinted Low E tempered glass (FG-ETT).
  3. Minimum Thickness: 1/4 inch.
  4. Tint: Tint color as indicated on Drawings, if not indicated on Drawings as selected by Architect.
- E. Insulating Glass:
1. Insulating Glass: ASTM E2190 certified by Insulating Glass Certification Council and Insulating Glass Manufacturers Alliance; [with Low E coating on surface 2] [and] glass elastomer edge seal; purge interpane space with dry air; tested in accordance with ASTM E2188 for unit performance and ASTM E2189 for resistance to fogging.
    - a. Insulating Glass Unit Edge Seal Construction: Aluminum, bent and spot welded corners.
    - b. Double Pane Insulating Vision Glass (IG-DP):
      - 1) Total Unit Thickness: 5/8 inch.
      - 2) Outer Pane: Glass Type [\_\_\_\_\_].
      - 3) Inner Pane: Glass Type [\_\_\_\_\_].
- F. Bullet Resistant Glazing:
1. LEXGARD® MP-750 Laminate: 3-ply, clear, extruded polycarbonate and acrylic sheet of the following construction:
    - a. 1/8 inch polycarbonate sheet with high AR abrasion-resistant surface.
    - b. Polyurethane bonding interlayer.
    - c. 1/2 inch Acrylic sheet.
    - d. Polyurethane bonding interlayer.
    - e. 1/8 inch polycarbonate sheet with high AR abrasion-resistant surface.
    - f. Material shall have a flexural strength of at least 13,500 psi per ASTM D790; and shall have AR (high performance abrasion-resistant) surfaces for enhanced service life and resistance to marring. Material shall conform to applicable flammability code as a CC-1 rated Approved Light Transmitting Plastic.
    - g. Level 1 - 9mm or .38 Special caliber rated.
  2. SPARTECH POLYCAST MP 1.25 Acrylic
    - a. Monolithic bullet resistant acrylic 1.25 inches thick.

- b. Super Abrasion Resistant Coating.
- c. Greater than 90% light transmission.
- d. 9,500 psi tensile strength.
- e. Level 1- 9mm or .38 Special caliber rated.
- 3. LEXGARD® SP1250 laminate: 4-ply, clear, polycarbonate of the following construction:
  - a. 1/8 inch polycarbonate sheet with high AR abrasion-resistant surface.
  - b. Polyurethane bonding interlayer.
  - c. 1/2 inch polycarbonate sheet.
  - d. Polyurethane bonding interlayer.
  - e. 1/2 inch polycarbonate sheet.
  - f. Polyurethane bonding interlayer.
  - g. 1/8 inch polycarbonate sheet with high AR abrasion-resistant surface.
  - h. Material shall have a flexural strength of at least 13,500 psi per ASTM D790; and shall have AR (high performance abrasion-resistant) surfaces for enhanced service life and resistance to marring. Material shall conform applicable flammability code as a CC-1 rated Approved Light Transmitting Plastic.
  - i. Level 3 - .44 Magnum caliber rated.

## 2.6 SECURITY DEVICE ACCESSORIES

- A. Security Lock Bar: Sliding aluminum lock bar.
- B. Auto-Lock Handle: Stainless steel constructed auto-locking handle on all self-closing sliders to prevent intrusion.
- C. Electric Auto-Lock: 3/4 inch stainless steel pin automatically locks behind electric window units to prevent intrusion.
- D. Hook-Lock: Maximum security Adams Rite style hook lock on all sliders.

## 2.7 ELECTRICAL REQUIREMENTS

- A. Electrical Windows: 120V / 60 Hz, 20 amp branch circuit, single phase. Conforms to UL Standard 325 – Certified to CAN/CSA C22.2 NO. 247.

## 2.8 FABRICATION

- A. Fabricate window to dimensions indicated on Drawings.
- B. Fabricate windows, drawers and accessories to provide a complete system for assembly of components and anchorage of window, drawers and accessories.
  - 1. Provide units that are reglazable from the secure side without dismantling the nonsecure side of framing.
  - 2. Prepare security windows for glazing unless preglazing at the factory is indicated.
- C. Provide weep holes and internal water passages for exterior security windows to conduct infiltrating water to the exterior.

- D. Rigidly fit and secure joints and corners with internal reinforcement. Make joints and connections flush, hairline, and weatherproof. Fully weld corners.
  - 1. Fabricate framing with manufacturer's standard, internal opaque armoring in thicknesses required for security windows to comply with ballistics-resistance performance indicated.
- E. Prepare components with reinforcement required for hardware.
- F. Welding: To greatest extent possible, weld before finishing and in concealed locations to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- G. Metal Protection: Separate dissimilar metals to protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- H. Factory-cut openings in glazing for speaking apertures.
- I. Preglazed Fabrication: Preglaze window units at factory, where required for applications indicated.
- J. Weather Stripping: Factory applied.
- K. Bottom Sills: Stainless steel construction, no bottom tracks and no pop rivets.
- L. Handles: Stainless steel, manufacturer's standard profile and finish.

## 2.9 SHOP FINISHING

- A. Aluminum Finishes:
  - 1. Clear Anodized Aluminum Surfaces: AA-M10C22A31 non-specular as fabricated mechanical finish, medium matte chemical finish, and Architectural Class II 0.7 mils (0.018 mm) clear anodized coating.
    - a. Conform to AAMA 611
- B. Concealed Steel Items: [Galvanized in accordance with ASTM A123 to thickness Grade 85, 2.0 oz/sq ft (610 gm/sq m).
- C. Stainless Steel: 304 Stainless Steel with NAAMM No. 3 finish.
- D. Apply bituminous paint to concealed metal surfaces in contact with cementitious or dissimilar materials.
- E. Touch-Up Primer for Galvanized Steel Surfaces: SSPC Paint 20 zinc rich.
- F. Extent of Finish:
  - 1. Apply factory coating to all surfaces exposed at completed assemblies.
  - 2. Apply finish to surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
  - 3. Apply touch-up materials recommended by coating manufacturer for field application to cut ends and minor damage to factory applied finish.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify construction is ready to receive Products specified in this section.
- C. Verify rough openings are correct size and in correct location.
- D. Examine roughing-in for embedded and built-in anchors to verify actual locations of security window connections before security window installation.
- E. Inspect built-in and cast-in anchor installations, before installing security windows, to verify that anchor installations comply with requirements. Prepare inspection reports.
  - 1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
  - 2. Perform additional inspections to determine compliance of replaced or additional work. Prepare anchor inspection reports.
- F. For glazing materials whose orientation is critical for performance, verify installation orientation.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Furnish frames and anchors to other sections as required for installation in surrounding partition and casework construction.

### 3.3 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Align Products plumb, level and square.
- C. Rigidly secure Products to adjacent supporting construction.
- D. Glaze windows in accordance with manufacturer's instructions and Section 08800 Glazing.
- E. Seal perimeter joints in accordance with Section 079200 Joint Sealants.
- F. Connect electrical components to power source.
- G. Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended in writing by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

### 3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements {01700 - Execution Requirements}: Requirements for adjusting.
- B. Adjust horizontal-sliding, transaction security windows to provide a tight fit at contact points for smooth operation and a secure enclosure.
- C. Adjust transaction drawers to provide a tight fit at contact points for smooth operation and [weathertight and] secure enclosure.
- D. Remove and replace defective work, including security windows that are warped, bowed, or otherwise unacceptable.

### 3.5 CLEANING AND PROTECTION

- A. Section 01 70 00 - Execution and Closeout Requirements {01700 - Execution Requirements}: Requirements for cleaning.
- B. Remove protective material from factory finished surfaces.
- C. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.
- D. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.
- E. Clean metal and glass surfaces to polished condition.
  - 1. Lubricate sliding security window hardware.
  - 2. Lubricate transaction drawer hardware.
- F. Provide temporary protection to ensure that security windows are without damage at time of Substantial Completion.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable security windows and security windows with transaction drawers.

END OF SECTION

## SECTION 088000 - GLAZING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
  - 1. Windows.
  - 2. Doors.
  - 3. Storefront framing.
  - 4. Glazed entrances.
  
- B. Related Sections:
  - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts."
  - 2. Section 084423 "Glazed Aluminum Curtain Walls"
  - 3. Section 088300 "Mirrors."

#### 1.2 DEFINITIONS

- A. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
  
- B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, using the following design criteria:
  - 1. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
    - a. Wind Design Data: As indicated on Structural Drawings.
    - b. Basic Wind Speed: As indicated on Structural Drawings.
  
  - 2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.



- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
  - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glass Samples: For each type of the following products; 12 inches (300 mm) square.
  - 1. Insulating glass.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass and glazing products, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulating glass.
- C. Warranties: Sample of special warranties.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- C. Source Limitations for Glass: Obtain laminated glass from single source from single manufacturer for each glass type.
- D. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
- E. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these

publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
  2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- F. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Install glazing in mockups specified in Section 084113 "Aluminum-Framed Entrances and Storefronts" -to match glazing systems required for Project, including glazing methods.
  2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- H. Preinstallation Conference: Conduct conference at Project site.
1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  2. Review temporary protection requirements for glazing during and after installation.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
  - B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.
- 1.8 PROJECT CONDITIONS
- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
- 1.9 WARRANTY
- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
1. Warranty Period: Five years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
  2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
- C. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes enhanced-protection testing requirements in ASTM E 1996 for Wind Zone 4 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.
1. Large-Missile Test: For glazing located within 30 feet (9.1 m) of grade.
  2. Small-Missile Test: For glazing located more than 30 feet (9.1 m) above grade.
  3. Large-Missile Test: For all glazing, regardless of height above grade.

- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
  2. For laminated-glass lites, properties are based on products of construction indicated.
  3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
  4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
  5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
  6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

## 2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
  2. For uncoated glass, comply with requirements for Condition A.
  3. For coated vision glass, comply with requirements for Condition C (other coated glass).
- C. Reflective-Coated Vision Glass: ASTM C 1376, coated by pyrolytic process or vacuum deposition (sputter-coating) process, and complying with other requirements specified.
1. Basis-of-Design Product: Subject to compliance with requirements, provide SN68 by Guardian or comparable product by another manufacturer
- Type G3:** Insulated glass unit: Guardian SN68 - 1-5/16" thick outer pane of clear glass with low E coating. Inner pane of clear glass.  
Visible light transmission – 68%, shading coefficient .43
- Type G4:** Insulated glass unit: Guardian SN68- 1-5/16" thick outer pane of clear glass with low E coating. Inner pane of clear glass.  
Visible light transmission – 68%, shading coefficient .43  
Spandrel - color to match architects' sample on #3 surface.
- Type G5:** Insulated glass unit: Guardian SN68- 1-5/16" thick outer pane of clear glass with low E coating. Inner pane of clear glass.  
Visible light transmission – 68%, shading coefficient .43  
Spandrel Ceramic Frit on #4 surface. Frit color to match architect's sample.

## 2.3 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
1. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written recommendations.
  2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
  3. Interlayer Color: Clear.
- B. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph in "Glass Products, General" Article, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
1. Construction: Laminate glass with one of the following to comply with interlayer manufacturer's written recommendations:
    - a. Polyvinyl butyral interlayer.
    - b. Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
    - c. Ionoplast interlayer.
    - d. Cast-in-place and cured-transparent-resin interlayer.
    - e. Cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film.
  2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
  3. Interlayer Color: Clear unless otherwise indicated.
- C. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

## 2.4 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
  2. Spacer: Manufacturer's standard spacer material and construction.
  3. Desiccant: Molecular sieve or silica gel, or blend of both.
- B. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated

Glass" Article as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article.

## 2.5 GLAZING GASKETS

- A. Compression Gaskets: Provided as part of aluminum framing systems.

## 2.6 GLAZING SEALANTS

### A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Applications: Glazing in frames without gaskets.

## 2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant

performance.

## 2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

## 2.9 MONOLITHIC-GLASS

- A. Clear float glass, heat-strengthened float glass or fully tempered float glass.
  - 1. Thickness: 6.0 mm.
  - 2. Provide safety glazing labeling.
- B. Tinted float glass, heat-strengthened float glass or fully tempered float glass.
  - 1. Thickness: 6.0 mm.
  - 2. Provide safety glazing labeling.
- C. Ceramic-coated spandrel glass, heat-strengthened float glass or fully tempered float glass.
  - 1. Thickness: 6.0 mm.
  - 2. Coating Location: Second surface.
  - 3. Coating Color: Selected by Architect.
  - 4. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.

## 2.10 LAMINATED-GLASS

- A. Clear laminated glass with two plies of float glass, heat-strengthened float glass or fully tempered float glass.
  - 1. Thickness of Each Glass Ply: 6.0 mm.
  - 2. Interlayer Thickness: 0.060 inch (1.52 mm).
  - 3. Provide safety glazing labeling.

## 2.11 INSULATING-LAMINATED-GLASS

- A. Tinted, insulating laminated glass.

1. Overall Unit Thickness: 1-5/16 inch (30 mm).
2. Thickness of Outdoor Lite: 6.0 mm.
3. Outdoor Lite: Tinted heat-strengthened float glass or fully tempered float glass.
4. Interspace Content: Air.
5. Indoor Lite: Clear laminated glass with two plies of float glass heat-strengthened float glass or fully tempered float glass.
  - a. Thickness of Each Glass Ply: 6.0 mm.
  - b. Interlayer Thickness: 0.060 inch (1.52 mm).
6. Center of Glass U-Value: 0.29 maximum.
7. Assembly U-Value: 0.46 maximum.
8. Solar Heat Gain Coefficient: 0.25 maximum.
9. Shading Coefficient: 0.2.
10. Visible Light Transmittance: 23 percent.
11. Exterior Reflectance: 6 percent.
12. Provide safety glazing labeling.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
  1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  2. Presence and functioning of weep systems.
  3. Minimum required face and edge clearances.
  4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

#### 3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and



other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
  - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
  - 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

#### 3.4 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and

installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

### 3.5 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

### 3.6 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

## SECTION 088300 - MIRRORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following types of silvered flat glass mirrors.
  - 1. Annealed monolithic glass mirrors.

#### 1.2 DEFINITIONS

- A. Deterioration of Mirrors: Defects developed from normal use that are attributable to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning mirrors contrary to mirror manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Provide mirrors that will not fail under normal usage. Failure includes glass breakage and deterioration attributable to defective manufacture, fabrication, and installation.

#### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
  - 2. Mirror hardware.
- B. LEED Submittal:
  - 1. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
- C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.
- D. Product Certificates: For each type of mirror, signed by product manufacturer.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed mirror glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in mirror installations with a record of successful in-service performance.
- B. Source Limitations for Mirrors: Obtain mirrors from one source for each type of mirror indicated.
- C. Source Limitations for Mirror Glazing Accessories: Obtain mirror glazing accessories from one source for each type of accessory indicated.
- D. Glazing Publications: Comply with the following published recommendations:
  - 1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
  - 2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors, protected from moisture including condensation.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form, made out to Owner and signed by mirror manufacturer agreeing to replace mirrors that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below:
  - 1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 SILVERED FLAT GLASS MIRROR MATERIALS

- A. Clear Glass Mirrors: ASTM C 1503, Mirror Select Quality.
  - 1. Nominal Thickness: 6.0 mm.

#### 2.2 MISCELLANEOUS MATERIALS

- A. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- B. Mirror Mastic: An adhesive setting compound, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
  - 1. VOC Content: Not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.3 FABRICATION

- A. Mirror Sizes: To suit Project conditions, cut mirrors to final sizes and shapes.
- B. Mirror Edge Treatment: Flat polished edge.
  - 1. Seal edges of mirrors after edge treatment to prevent chemical or atmospheric penetration of glass coating.
  - 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance.
  - 1. Proceed with mirror installation only after unsatisfactory conditions have been corrected and surfaces are dry.

### 3.2 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Provide a minimum air space of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

- C. For wall-mounted mirrors, install mirrors with mirror hardware.
  - 1. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

### 3.3 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

END OF SECTION 088300

***DIVISION 9***

***FINISHES***

## SECTION 092216 - NON-STRUCTURAL METAL FRAMING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

#### 1.2 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

#### 1.3 INFORMATIONAL SUBMITTALS

- ##### A. Evaluation Reports: For dimpled steel studs and runners, from ICC-ES.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- ##### A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

#### 2.2 FRAMING SYSTEMS

- ##### A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized unless otherwise indicated.

- ##### B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.

##### 1. Steel Studs and Runners:

- a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
- b. Depth: As indicated on Drawings.

##### 2. Dimpled Steel Studs and Runners:



- a. Minimum Base-Metal Thickness: As required to equal strength of steel studs above.
  - b. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide the following:
1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- D. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
  2. Depth: As indicated on Drawings.
- E. Resilient Furring Channels:
1. Minimum Base-Metal Thickness: 0.875 inch (22.2 mm), steel sheet members designed to reduce sound transmission.
    - a. Configuration: Asymmetrical.
  2. Depth: As indicated on Drawings.

## 2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:
1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
    - a. Type: Post installed, expansion anchor.
  2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- D. Furring Channels (Furring Members):
1. Steel Studs and Runners: ASTM C 645.
    - a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
    - b. Depth: As indicated on Drawings.

2. Dimpled Steel Studs and Runners: ASTM C 645.
  - a. Minimum Base-Metal Thickness: As required to equal strength of steel studs above.
  - b. Depth: As indicated on Drawings.
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

## 2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
  1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### 3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
  1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
  - 2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
  - 3. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
  - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

### 3.5 INSTALLING SUSPENSION SYSTEMS

- A. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- B. Suspend hangers from building structure as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling

plenum that are not part of supporting structural or suspension system.

- a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
  3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  5. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- C. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

## SECTION 092900 - GYPSUM BOARD

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
3. Product Data for Credit IEQ 4.1: For adhesives used to laminate gypsum board panels to substrates, documentation including printed statement of VOC content.

#### 1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

#### 1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
1. Indications that panels are wet, or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

### 2.2 GYPSUM BOARD, GENERAL

- A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 20 percent.
- B. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- C. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

### 2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
  1. Thickness: 5/8 inch (15.9 mm).
  2. Long Edges: Tapered.

### 2.4 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
  2. Core: 5/8 inch (15.9 mm), Type X.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

### 2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
  1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
  2. Shapes:
    - a. Cornerbead.

- b. L-Bead: L-shaped; exposed long flange receives joint compound.
- c. Expansion (control) joint.

## 2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
  - 1. Interior Gypsum Board: Paper.
  - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
  - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
  - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
  - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

## 2.7 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
  - 1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
- D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  - 1. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  - 1. Type X: All surfaces.
- B. Single-Layer Application:



1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
2. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

### 3.4 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings, or if not shown, according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  1. Cornerbead: Use at outside corners unless otherwise indicated.
  2. L-Bead: Use where indicated.

### 3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not

intended to receive tape.

- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

### 3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet, or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

## SECTION 093000 - TILING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Porcelain floor tile.
2. Porcelain wall tile.

B. Related Sections include the following:

1. Division 07 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Division 09 Section "Gypsum Board" for glass-mat, water-resistant backer board.

#### 1.2 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6.

#### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Assembled samples with grouted joints for each type and composition of tile and for each color and finish required, at least 12 inches square and mounted on rigid panel. Use grout of type and in color or colors approved for completed work.
3. Full-size units of each type of trim and accessory for each color and finish required.

C. LEED Submittal:

1. Credit EQ 4.1: Manufacturers' product data for sealants, including printed statement of VOC content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

D. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile

manufacturer and Installer.

- E. Product Certificates: For each type of product, signed by product manufacturer.
- F. Material Test Reports: For each tile-setting and -grouting product.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
  - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.
- D. Store liquid latexes in unopened containers and protected from freezing.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

#### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

## PART 2 - PRODUCTS

### 2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
  - 1. As indicated in the Finish Schedule for each building and Legend Sheet G-11.
- D. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

### 2.2 TILE PRODUCTS

- A. Unglazed Wall and Floor Tile: Flat tile as follows:
  - 1. Composition: Porcelain.
  - 2. Facial Dimensions: As indicated in Finish Schedule and Legend in Drawings.
  - 3. Thickness: 3/8 inch.
  - 4. Face: Plain with square or cushion edges.
  - 5. Basis-of-Design Product: As indicated in Section 090690 Color Schedule or a comparable product.
    - Basis of Design
    - Crossville, Inc.
    - 349 Sweeney Drive, Crossville, TN 38555
    - 931-484-2110 <https://www.crossvilleinc.com/>
    - Rep: Brian Banter (850)505-7676 c(850)723-7047 bbanter@crossvillestudios.com
- B. Wall Tile Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as follows, selected from manufacturer's standard shapes:
  - 1. Base for Thin-Set Mortar Installations: Straight, module size as indicated in Section

090690 Color Schedule.

2. External Corners for Thin-Set Mortar Installations: Surface bullnose.
3. Internal Corners: Field-buttet square corners except with coved base and cap angle pieces designed to fit with stretcher shapes.

### 2.3 SETTING AND GROUTING MATERIALS

A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4, consisting of the following:

1. Prepackaged dry-mortar mix containing dry, redispersible, ethylene vinyl acetate additive to which only water must be added at Project site.
  - a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.

B. Polymer-Modified Tile Grout: ANSI A118.7, color as indicated.

1. Polymer Type: Either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
  - a. Sanded grout mixture for joints 1/8 inch and wider.

### 2.4 MISCELLANEOUS MATERIALS

A. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F per ASTM D 87.
2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

C. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints that does not change color or appearance of grout.

### 2.5 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and

other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
  - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
  - 3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not, factory blended, either return to manufacturer or blend tiles at Project site before installing.
- C. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

#### 3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- E. Jointing Pattern: Lay tile in grid pattern shown on the drawings. Provide uniform joint widths, unless otherwise indicated.
- F. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
  - 1. Locate joints in tile surfaces directly above joints in concrete substrates.
- G. Grout tile to comply with requirements of the following tile installation standards:
  - 1. For ceramic tile grouts (sand-portland cement; dry-set, commercial portland cement; and latex-portland cement grouts), comply with ANSI A108.10.

### 3.4 FLOOR TILE INSTALLATION

- A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.
  - 1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
    - a. Tile floors in wet areas.
    - b. Tile floors composed of tiles 8 by 8 inches or larger.
- B. Joint Widths: Install tile on floors with the following joint widths:
  - 1. Porcelain Tile: 1/4 inch.
- C. Grout Sealer: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

### 3.5 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
- B. Joint Widths: Install tile on walls with the following joint widths:
  - 1. Porcelain Tile: 1/4 inch.



### 3.6 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  - 1. Remove latex-portland cement grout residue from tile as soon as possible.
  - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
  - 3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

### 3.7 FLOOR TILE INSTALLATION SCHEDULE

- A. Tile Installation: Interior floor installation on concrete; thin-set mortar; TCA F113 and ANSI A108.5.
  - 1. Tile Type: Porcelain tile.
  - 2. Thin-Set Mortar: Latex- portland cement mortar.
  - 3. Grout: Polymer-modified sanded grout.

### 3.8 WALL TILE INSTALLATION SCHEDULE

- A. Tile Installation: Interior wall installation over glass-mat, water-resistant backer board; thin-set mortar; TCA W245 and ANSI A108.5.
  - 1. Tile Type: Porcelain wall tile.
  - 2. Thin-Set Mortar: Latex- portland cement mortar.
  - 3. Grout: Polymer-modified unsanded grout.

END OF SECTION 093000

## SECTION 093001 - TILE SHOWER COMPONENTS AND WATERPROOFING MEMBRANE

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Waterproofing Membrane.
- B. Floor drain, with integrated bonding flange.
- C. Shower Waterproofing: Prefabricated substrates, waterproofing membrane, floor drain with integrated bonding flange, and sealant.
- D. Drainage membranes.
- E. Setting Materials: Adhesives, mortars, grouts, and sealants.

#### 1.2 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry. Plywood subfloor and underlayment.
- B. Section 07 90 00 - Joint Sealants.
- C. Section 09 28 13 - Cementitious Backing Boards. Gypsum board and tile backer boards.
- D. Section 09 30 00 - Tiling. Tile and Installation of Tile Setting materials and Accessories.
- E. Section 09 30 01 - Tiling. Shower trays, bench, niche, sealing compound, waterproofing membrane, drainage panels, drainage membrane compatible with floor drains.
- F. Section 22 13 19 - Sanitary Drains. Product and installation requirements for floor and shower drain materials.

#### 1.3 REFERENCES

- A. American National Standard Institute (ANSI)
  - 1. ANSI A108 / A118 / A136.1 - American National Standards Specifications for The Installation of Ceramic Tile
- B. International Association of Plumbing and Mechanical Officials (IAPMO):
  - 1. IAPMO IGC 195 - Interim Guide Criteria for Floor Drain with Integrated Bonding Flange.
- C. Tile Council of North America (TCNA):
  - 1. Handbook for Ceramic Tile Installation.
- D. Underwriters Laboratories (UL).

#### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and finish.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum five years' experience.
- B. Source Limitations for Setting Materials and Accessories: Obtain product of a uniform quality for each application condition from a single manufacturer.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Architect.
  - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
  - 3. Refinish mock-up area as required to produce acceptable work.
- D. Preinstallation Conference: Conduct conference at the Project site.
  - 1. Convene one week prior to commencing work of this section.
  - 2. Require attendance of installation material manufacturer, tile supplier, tile installer and installers of related work. Review installation procedures and coordination required with related work.
  - 3. Meeting agenda includes but is not limited to:
    - a. Surface preparation.
    - b. Tile and installation material compatibility.
    - c. Edge protection, transition, and pre-fabricated movement joint profiles.
    - d. Waterproofing techniques.
    - e. Crack isolation techniques.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weathertight location.

#### 1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

## 1.8 COORDINATION

- A. Coordinate Work with other operations and installation of floor finish materials to avoid damage to installed materials.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Schluter Systems, L.P.; 194 Pleasant Ridge Road; Plattsburgh, NY 12901-5841; ASD Tel: (800) 472-4588; Fax: (800) 477-9783; E-mail: [specassist@schluter.com](mailto:specassist@schluter.com); Web: [www.schluter.com](http://www.schluter.com).
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

### 2.2 WATERPROOFING MEMBRANE

- A. Schluter-KERDI: 0.008 inch (0.2 mm) thick, orange polyethylene membrane, with polypropylene fleece laminated on both sides.
  - 1. Meets or exceeds requirements of the "American national standard specifications for load bearing, bonded, waterproof membranes for thin-set ceramic tile and dimension stone installation A118.10.
  - 2. Listed by cUPC. Evaluated by ICC-ES; Report No. ESR-2467.
  - 3. Corners and seals:
    - a. Matching preformed inside corners. Color: Gray.
    - b. Matching preformed outside corners. Color: Gray.
    - c. Matching preformed pipe seals. Color: Gray.
    - d. Matching preformed mixing valve seals. Color: Gray.
- B. Schluter-KERDI-BAND: Seams and Corners material 0.004 inch (0.1 mm) thick, orange polyethylene membrane, with polypropylene fleece laminated on both sides.
  - 1. Width: As required to turn up walls - 6" with a 2" overlap.

### 2.3 FLOOR DRAIN WITH INTEGRATED BONDING FLANGE

- A. Schluter-KERDI-LINE DRAIN, Brushed Stainless Steel: Linear floor drain consisting of a formed stainless steel channel body and grate assembly.
  - 1. Seamlessly adjustable to tile thickness from 1/8 to 1 inch (3 to 25 mm).
  - 2. Channel Body: 2-1/4 inch (57 mm) wide trough, 2 inch (50 mm) no-hub outlet, and 7/8 inch (22 mm) wide bonding flange laminated with a collar made of Schluter-KERDI waterproofing membrane.
  - 3. Drain Type: As referenced in methods B422 and B422 STONE in the Tile Council of North America Handbook for Ceramic, Glass, and Stone Tile Installation.
  - 4. Channel Body Material: Stainless Steel 304 (1.4301 equals V2A).
  - 5. Channel Body and Grate Nominal Length:
  - 6. Channel Body and Grate Nominal Length: 56 inch (140 cm).
  - 7. Grate Frame Height: Height as required to coordinate with tile selection and setting system selected.
  - 8. Grate Design: Brushed stainless steel 304 (1.4301 equals V2A) grate with square perforations and locking mechanism with a 3/8 inch (10 mm) wide brushed stainless

steel grate frame and 2-1/8 inch (54 mm) wide grate insert that together form the visible surface.

9. Drain Outlet: Center.
10. Drain Grate Connector Plate: Brushed stainless steel 304 (1.4301 equals V2A).

#### 2.4 WATERPROOF BUILDING PANEL FOR CERAMIC AND STONE TILE

- A. Schluter-KERDI-BOARD: Rigid extruded polystyrene foam building element panel, with reinforcement material and polypropylene fleece webbing laminated on both sides for thin-set ceramic tile and dimension stone Installations.
  1. Panel Thickness: 1/2 inch (12.5 mm).
  2. Panel Size: 48 x 96 inch (122 by 244 cm).

#### 2.5 DRAINAGE MEMBRANES

- A. Schluter-TROBA-PLUS: Orange polyethylene sheet with 5/16 inch (8 mm) high, truncated cone-shaped studs, covered with a polypropylene water-permeable filter fabric.

#### 2.6 SHOWER NICHE

- A. Schluter-KERDI-BOARD-SN is a pre-fabricated shower niche made of KERDI-BOARD that can be installed in both KERDI and KERDI-BOARD wall assemblies. The shower niche features a 1/2" (12.5mm) thick by 2" ( 50 mm) wide integrated bonding flange and the overall size is 12" x 12" ( 30 x 30 cm)

#### 2.7 SETTING MATERIALS

- A. Schluter-SET Premium Unmodified Thin Set Mortar: Premium unmodified sag-resistant thin-set mortar specifically formulated for use with Schluter membranes and boards. Suitable for use with ceramic, porcelain, and stone tile, including large and heavy tile, in conjunction with Schluter-Systems' uncoupling and waterproofing membranes. Meets the requirements of ANSI A118.1T.
  1. Color: White.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 093000

## SECTION 095113 - ACOUSTICAL PANEL CEILINGS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which suspension systems will be attached.
  - 3. Size and location of initial access modules for acoustical panels.
  - 4. Items penetrating finished ceiling including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
  - 5. Perimeter moldings.
- B. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
  - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Retain "Pressurized Plenums" Subparagraph below to comply with the Ceilings & Interior Systems Construction Association's (CISCA) recommendations for cleaning duct system and protecting ceiling units in pressurized plenums from damage and soiling caused by blowing dirt and dust that may be present when duct system is first operated.

1.8 WARRANTY

- A. Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
  - 1. Defects in material or factory workmanship.
- B. Ceiling panels one source manufacturer is Thirty (30) years from date of substantial completion.
- C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Design-Builder under the requirements of the Contract Documents.

PART 2 - PRODUCTS



## 2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
  - 2. Smoke-Developed Index: 50 or less.

## 2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations:
  - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
  - 2. Suspension System: Obtain each type from single source from single manufacturer.
- B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- C. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 20 percent by weight.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance unless otherwise indicated.
  - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

## 2.3 ACOUSTICAL PANELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Armstrong World Industries, Inc.
  - 2. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
  - 1. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
  - 2. Pattern: C (perforated, small holes) E (lightly textured).
- C. AC1-01: Armstrong Optima 3352 (Basis of Design)
  - 1. Color: White.
  - 2. LR: Not less than 0.88

3. NRC: Not less than 0.95
4. CAC: 26
5. Edge/Joint Detail: Square.
6. Thickness: 1" inch
7. Modular Size: 24 by 24 inch
8. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

D. ACT-02: Armstrong Kitchen-Zone 673 (Basis of Design)

1. Color: White.
2. LR: .89
3. NRC:
4. CAC: 33
5. Edge/Joint Detail: Square
6. Thickness: 5/8 inch (15 mm).
7. Modular Size: 24 by 24 inch (610 by 610 mm).
8. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated.
  1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
    - a. Type: Post-installed expansion anchors.
    - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
  2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory

devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
  2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.
- E. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

## 2.5 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Armstrong World Industries, Inc.
  2. CertainTeed Corp.
  3. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Wide-Face, Capped, Double-Web, Hot-Dip Galvanized, G60 (Z180), Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation; with prefinished, cold-rolled, 02/11-inch- (24-mm-) wide aluminum caps on flanges.
1. Structural Classification: Intermediate -duty system.
  2. Face Design: Flat, flush.
  3. Face Finish: As indicated in Section 090690 Color Schedule.

## 2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Armstrong World Industries, Inc.
  2. CertainTeed Corp.
  3. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and

suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.

2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

## 2.7 ACOUSTICAL SEALANT

- A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
  2. Concealed Joints: Nondrying, nonhardening, non-skinning, nonstaining, gunnable, synthetic-rubber sealant.
  3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders and comply with layout shown on reflected ceiling plans.

### 3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook Recommendations for Direct-Hung Acoustical Tile and Lay-In Panel Ceilings".
- B. Suspend ceiling hangers from building's structural members and as follows:
  1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
  3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Do not attach to other suspended building systems.
  4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  7. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
  8. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
  2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

### 3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and

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suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

## SECTION 096513 – RESILIENT BASE AND ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Resilient base
2. Resilient molding accessories
3. Adhesive and related accessories

- B. Related Sections:

1. Division 07 Section "Joint Sealants" for single-component and multi-component elastomeric, latex, silicone, urethane and other joint sealants.
2. Division 09 Section "Linoleum Flooring" for linoleum floor coverings.
3. Division 09 Section "Resilient Tile Flooring" for resilient floor tile.

#### 1.3 ACTION SUBMITTALS

- A. Submit items in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated, submit two (2) copies of manufacturers' product data, installation instructions, and accessories specified and/or required by manufacturer.
- C. Samples for Verification: Submit one (1) Sample for each type of product indicated in manufacturer's standard-size, of each resilient product color, texture, and pattern required.
- D. Control Samples: Contractor to retain duplicate set of submitted Samples from the same production as the submitted Samples on site until the Project is completed.
- E. Product Schedule: See Finish Material Listing in Finish Drawings.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials/attic stock that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Maintenance Materials: Contractor to coordinate with Owner the quantity of maintenance materials required for each product.

#### 1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
  1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Mockups: Provide resilient products with mockups specified in other Sections.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

#### 1.7 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
  1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

### PART 2 - PRODUCTS

#### 2.1 RESILIENT BASE

- A. Resilient Base:
  1. Manufacturers: Subject to compliance with requirements, see Finish Material Listing in Finish Drawings for Basis of Design.
- B. Resilient Base Standard: ASTM F 1861
  1. Material Requirement: Type TS (rubber, vulcanized thermoset)
  2. Manufacturing Method: Group I (solid, homogeneous)



- C. Style: See finish materials listing in the finish drawings.
- D. Minimum Thickness: See Finish Material Listing in Finish Drawings.
- E. Height: See Finish Material Listing in Finish Drawings.
- F. Lengths: Coils in manufacturer's standard length
- G. Outside Corners: Job formed
- H. Inside Corners: Preformed
- I. Finish Colors and Patterns: See Finish Material Listing in Finish Drawings.

## 2.2 RESILIENT MOLDING ACCESSORY

- A. Resilient Molding Accessory:
  - 1. Manufacturers: Subject to compliance with requirements, see Finish Material Listing in Finish Drawings for Basis of Design. Description: See Finish Material Listing and floor transition details in Finish Drawings.
- B. Material: As standard with manufacturer.
- C. Profile and Dimensions: See Finish Material Listing and floor transition details in Finish Drawings.
- D. Colors and Patterns: See Finish Material Listing and floor transition details in Finish Drawings.

## 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
  - 1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), except that adhesive for rubber stair treads shall have a VOC content of 60 g/L or less.
- C. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.
- D. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.
- E. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair

tread manufacturer.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
  - 4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after all substrates passtesting.
    - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate allowed by manufacturer(s) for each product specified in 24 hours.
    - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum relative humidity level measurement allowed by manufacturer(s) for each product specified.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until they are same temperature as the space where they are to be installed.
  - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before

installation.

### 3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Inside Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Outside Corners:
  - 1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.

### 3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of all resilient floor covering that would otherwise be exposed per floor transition details.

### 3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- B. Perform the following operations immediately after completing resilient product installation:
  - 1. Remove adhesive and other blemishes from exposed surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.

1. Apply liquid floor polish per manufacturers' recommendations.
- E. Joint Sealant: Coordinate with floor finish material for requirements concerning applying sealant at door frames and other joints and penetrations.
- F. Cover resilient products until Substantial Completion.

END OF SECTION

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## SECTION 096519 – RESILIENT TILE FLOORING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Solid vinyl floor tile
2. Adhesive and related accessories
3. Surface-applied moisture mitigation and related products

- B. Related Sections:

1. Division 07 Section “Joint Sealants” for single-component and multi-component elastomeric, latex, silicone, urethane and other joint sealants.
2. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.

#### 1.3 ACTION SUBMITTALS

- A. Submit items in accordance with Division 01 Section “Submittal Procedures.”
- B. Product Data: For each type of product indicated, submit two (2) copies of manufacturers’ product data, installation instructions and accessories specified and/or required by manufacturer.
- C. Shop Drawings: Submit Drawings for each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
  1. Show details of special patterns, type, locations and direction. See Finish Drawings.
  2. Transition details to other flooring materials.
- D. Samples for Verification: Submit one (1) Sample, maximum 6 x 6 inches in size, illustrating color and pattern of floor tile required.
- E. Control Samples: Contractor to retain duplicate set of submitted Samples from the same production as the submitted Samples on site until the Project is completed.

- F. Product Schedule: See Finish Material Listing in Finish Drawings.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile, provide maintenance manuals including manufacturers' written instructions for cleaning and maintenance.

#### 1.5 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials/attic stock that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Maintenance Materials: Contractor to coordinate with Owner the quantity of maintenance materials required for each product.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

- 1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

- 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

- C. Prior to installation of flooring, submit written certification by both flooring and adhesive manufacturers that condition of sub-floor is acceptable.

- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution including substrate preparation and required testing.

- 1. Build mockups for floor tile including resilient base and accessories.
    - a. Size: Minimum 100 sq. ft. for each type, color, and pattern in locations directed by Architect/Interior Designer.
    - b. Maintain accepted mock-up throughout the construction process.
    - c. Accepted and approved mock-up may remain as part of the finished Work as a standard for subsequent Work.

- E. Contractor to schedule pre-installation conference with flooring sub-contractor, Architect/Interior Designer and Owner to review seaming diagrams, adhesives, floor preparation procedures, moisture mitigation procedures, bond/adhesion tests, and installation procedures.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

### 1.8 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to walking traffic for 48 hours and to rolling traffic for 72 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. FloorScore Compliance: Resilient tile flooring shall comply with requirements of FloorScore Standard developed by the Resilient Floor Covering Institute (RFCI).

### 2.2 SOLID VINYL FLOOR TILE

- A. Products: Subject to compliance with requirements, see Finish Material Listing for Basis of Design.
- B. Tile Standard: ASTM F 1700
- C. Size, Seaming Method, Colors and Patterns: See Finish Material Listing in Finish Drawings.



## 2.3 INSTALLATION MATERIALS

### A. Substrate Preparation Products:

1. Trowelable Leveling and Patching Compounds: Portland cement-based or blended hydraulic cement-based formulation provided or approved by floor covering manufacturer for applications indicated.
2. Moisture Mitigation Product – As approved by flooring manufacturer and adhesive manufacturer to provide warranted installation.

### B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.

1. Adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24): Not more than 50g/L
2. Coordinate with Owner any areas with heavy rolling equipment (patient rooms, trauma rooms, holding rooms, etc. and all associated corridors along travel route which may require additional preparation and/or adhesives.

### C. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

## 2.4 ACCESSORIES

### A. Patching:

1. Use only Portland based patching and leveling compounds. Do not install resilient floor covering over gypsum-based patching and/or leveling compounds.

### B. Sealing:

1. For sealing joints between the top of wall base or integral cove cap and irregular wall surfaces such as masonry, provide plastic filler applied according to the manufacturer's recommendations.

### C. Transition:

1. Provide transition/reducing strips tapered to meet abutting materials.

### D. Threshold:

1. Provide threshold of thickness and width as shown on the drawings.

### E. Resilient Edge Strips:

1. Provide resilient edge strips of width shown on the drawings, of equal gauge to the flooring, homogeneous vinyl or rubber composition, tapered or bullnose edge, with color to match or contrast with the flooring, or as selected by the Architect from standard colors available.

F. Metal Edge Strips:

1. Provide metal edge strips of width shown on the drawings and of required thickness to protect exposed edges of the flooring. Provide units of maximum available length to minimize the number of joints. Use butt-type metal edge strips for concealed anchorage or overlap-type metal edge strips for exposed anchorage. Unless otherwise shown, provide strips made of extruded aluminum with a mill finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content, moisture vapor emission, temperature, alkalinity, installation tolerance, moisture mitigation, and other conditions affecting performance of the Work.
- B. At areas which require moisture mitigation, brush blasting, bead blasting, shot blasting, scarifying or other substrate preparation, consult with Architect and Structural Engineer prior to performing Work.
- C. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
  1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
  3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates passtesting.
  4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after all substrates passtesting.
    - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of allowed / permissible by manufacturer(s) for each product specified in 24 hours.
    - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed

- with installation only after substrates have the maximum relative humidity level measurement allowed by manufacturer(s) for each product specified.
- c. If required, apply the moisture mitigation product per the manufacturer's recommendations and provide any additional calcium chloride testing of the prepared substrate per moisture mitigation manufacturer's recommendations prior to installation of floor covering and register results with the moisture mitigation manufacturer, General Contractor, Owner and Architect.
- C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
  - D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
  - E. Do not install floor tiles until they are same temperature as space where they are to be installed.
    - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
  - F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

### 3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
  - 1. Lay tiles square with room axis or as indicated in Finish Drawings.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
  - 1. Lay tiles with grain running in one direction or as indicated in Finish Drawings.
- D. Scribe, cut, seal and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color

and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

- H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. At areas receiving integral base, extend flooring material or pre-molded base up the wall to the height indicated on the drawings. Carefully miter corners and heat seal seams. The cut style at mitered corners must be consistent throughout entire project as approved at the pre-installation conference or as per approved mock-up.
  - 1. Install integral base cove cap. Clean thoroughly and apply sealant between the cove cap and wall and to bottom of door frame to floor. See Division 07 Section "Joint Sealants."
- J. Protect flooring installations and do not allow walking traffic for 24 hours or rolling loads for 72 hours after completion of installation to allow for setting and drying of adhesive.

#### 3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
  - 1. Remove adhesive and other blemishes from exposed surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid floor polish.
  - 1. Apply floor polish per manufacturer's recommendation.
- E. Joint Sealant: Apply sealant to resilient tile flooring at door frames and at other joints and penetrations.
- F. Cover floor tile until Substantial Completion.

END OF SECTION 096519

## SECTION 096813 – TILE CARPETING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Furnish labor, materials, tools and other equipment, and services necessary to provide surface preparation and the installation of carpet tile, including all components and accessory items required for a complete installation.
  - 1. Modular Carpet
- B. Work under this Section also includes moisture and alkalinity testing, and surface preparation of substrates as required for acceptance of carpet tile, including but not necessarily limited to, cleaning, small crack repair, patching, filling, any other Work required to provide an appropriate substrate.
- C. This specification shall be supplemented by any applicable federal, state and local building codes, guidelines, regulations, and standards adopted in the immediate geographic area of the Project; insurance rating organizations; including all other Authorities Having Jurisdiction.

#### 1.3 RELATED SECTIONS

- 1. Division 01 Section "Submittal procedures."
- 2. Division 02 Section "Selective Structure Demolition" for removing existing floor coverings.
- 3. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site prior to commencement of field installation with Contractor, Subcontractor, Architect/Designer and others, as required.
  - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
    - a. Review delivery, storage, and handling procedures.
    - b. Review ambient conditions and ventilation procedures.

- c. Review subfloor preparation procedures.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
  - 2. Include installation recommendations and accessories specified and/or required by manufacturer for each type of substrate.
  - 3. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
  - 4. Warranty: For each type indicated, copy of manufacturer's warranty.
- B. Shop Drawings: Show the following:
  - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
  - 2. Carpet tile type and color.
  - 3. Type of subfloor.
  - 4. Type of installation.
  - 5. Pattern of installation.
  - 6. Pattern type, location, and direction.
  - 7. Pile direction.
  - 8. Type, color, and location of insets and borders.
  - 9. Type, color, and location of edge, transition, and other accessory strips.
  - 10. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
  - 1. Carpet Tile: Submit one (1) full-size Sample.
  - 2. Exposed Edge, Transition, and Other Accessory Stripping: Submit one (1) 6-inch long Sample.
- D. Control Samples: Contractor to retain duplicate set of submitted Samples from the same production as the submitted Samples on site until the Project is completed.
- E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

## 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
  - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
  - 2. Precautions for cleaning materials and methods that could be detrimental to

carpet tile.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Maintenance Materials: Contractor to coordinate with Owner the quantity of maintenance materials required for each product.
  - 2. Deliver usable carpet tiles to Owner. Neatly package and wrap such carpet tiles for storage protection.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level. Verify Installer is approved by manufacturer, with a minimum of five years continuous, uninterrupted experience in successfully installing Work similar in material, design and extent to that indicated for this Project, whose Work has resulted in construction with a record of successful in-service performance, and who agrees to employ only skilled tradesmen with a minimum of five years experience.
- B. Fire-Test-Response Ratings: Provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 or ASTM E648 by a qualified testing agency.
- C. Carpet shall have smoke density development of 450 or less per NBS Smoke Chamber Test NFPA 258 or ASTM E 662.
- D. Prior to installation, submit written certification by both flooring and adhesive manufacturers that condition of sub-floor is acceptable.
- E. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Build mockups at locations and in sizes shown on Drawings.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Factory Runs: Produce carpet tile, of each type specified, in one factory run and from one dye lot. Guarantee colors and shades to be uniform throughout the run of material.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.
- B. Arrange, in advance of delivery, with General Contractor for secure, clean, dry storage space.

#### 1.10 FIELD CONDITIONS

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet Work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Install carpet tile after other finishing operations, including painting, have been completed.
- E. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

#### 1.11 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
  - 2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
  - 3. Warranty Period: Minimum 10 years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 CARPET TILE

- A. Products: See Finish Materials Listing in the Finish Drawings.
  - 1. Backing System: See Finish Materials Listing in the Finish Drawings.
  - 2. Size: See Finish Materials Listing in the Finish Drawings.
  - 3. Performance Characteristics: As follows:
    - a. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D 7330.
    - b. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
    - c. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
    - d. Tuft Bind: Not less than 3 lbf according to ASTM D1335.



- e. Delamination: Not less than 3.5 lbf/in. according to ASTM D 3936.
  - f. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
  - g. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
  - h. Resistance to Insects: Comply with AATCC24.
  - i. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
  - j. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) according to AATCC 16, Option E.
  - k. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC174.
  - l. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.
4. Basis of Design – Shaw Contract - See Color Schedule 090690  
Rep: Justin Bixenman - (334) 354-2703 [justin.bixenman@shawcontract.com](mailto:justin.bixenman@shawcontract.com)

## 2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
  - 1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Metal Edge/Transition Strips: See Floor Transition Details in the Finish Drawings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
  - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
  - 2. Subfloor finishes comply with requirements specified in Division 03 Section

"Cast-in-Place Concrete" for slabs receiving carpet tile.

3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
  4. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
- C. If required, apply a moisture mitigation product per the manufacturer's recommendations and provide any additional testing of the prepared substrate per moisture mitigation manufacturer's recommendations prior to installation of the carpet. Register results with moisture mitigation manufacturer, General Contractor, Owner and Architect.
- D. Proceed with installation only after substrates pass testing and unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

### 3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive
- C. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future

cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

- F. Install pattern parallel to walls and borders. See Finish Drawings per patterns and layouts.
- G. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.
- H. Install edge strips and trim in accordance with manufacturer's written instructions.

### 3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
  - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
  - 2. Remove yarns that protrude from carpet tile surface.
  - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile with non-staining building material paper, hard board or plywood to comply with CRI 104, Section 16, "Protecting Indoor Installations." Do not use plastic sheeting.
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 09 72 00  
VINYL WALLCOVERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Vinyl and Non-Woven Backing Wallcovering.
- B. Provide digitally printed wallcovering vinyl wallcovering, complete.
  - 1. Related Sections
    - a. Section 165000 - Lighting: Permanent during installation.
    - b. Section 092500 - Gypsum Board: Wall Substrates.
    - c. Section 099000 - Painting: Preparation and priming of substrate surfaces.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. E 84 Test Method for Surface Burning Characteristics of Building Materials.
- B. Wallcovering Association (WA):
  - 1. WA-101-2011 Quality Standard for Polymer Coated Fabric Wallcovering.
- C. Federal Specifications (FedSpec):
  - 1. CCC-W- 408A Wallcovering, Vinyl Coated
- D. Underwriters Laboratory, Inc. (UL)
  - 1. UL 723 Test for Surface Burning Characteristics of Building Materials
- E. National Fire Protection Agency (NFPA)
  - 1. NFPA 101 Life Safety Code
  - 2. NFPA 286 Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

1.4 ALLOWANCES

- A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.5 UNIT PRICES

- A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.
- B. Shop Drawings: Show location and extent of each wall-covering type. Indicate **pattern placement** seams and termination points.
  - a. Show complete pattern repeat.
  - b. Mark top and face of fabric.
- C. Samples for Verification: For each type of wall covering and for each color, pattern, texture, and finish specified,
  - 1. Wall-Covering Sample:
    - a. From same production run to be used for the Work, with specified **paint** applied.
    - b. Submit full-size samples, 54 inches wide by 36 inches long, cut from current production of each ground wallcovering selected to demonstrate quality, weight, color and embossing.
- D. Product Schedule: For wall coverings. **Use same designations indicated on Drawings.**

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.
- B. Submit manufacturer's written product certification that all furnished wallcovering ground meets or exceeds the specification requirements. Include certified copies of tests specified.
- C. Submit manufacturers' product data and installation instructions for each digitally printed wallcovering mural, adhesive and accessory required.
  - 1. Include data on physical properties, fire hazard classification and fire detection characteristics of wallcovering.
  - 2. Include manufacturer's recommendations for maximum permissible moisture content of substrates.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For wall coverings to include in maintenance manuals.
  - 1. Submit wallcovering ground manufacturer's written instructions for recommended maintenance of each type of wallcovering required.

1.9 QUALITY ASSURANCE

- A. Manufacturer: Provide each type of digitally printed vinyl wallcovering mural required produced by one manufacturer whose published product literature clearly indicates compliance of wallcovering ground with specified requirements.
- B. Applicator: Installation by skilled commercial wallcovering applicators with no less than three years of documented experience installing wallcovering murals of the types and extent specified for the project.
- C. Material Standards: Provide materials that meet or exceed Federal Specification CCC-W-408A and WA-101 Quality Standard for Polymer Coated Fabric Wallcovering for Type I and Type II wallcovering.
- D. Physical Properties: Provide wallcovering with the following physical properties when tested in accordance with ASTM D751.
  - 1. Total weight: 21 oz./lin. yd
  - 2. Tensile Strength: 50 X 55 Minimum (W x F)
  - 3. Tear Strength: 25 X 25 Minimum (W x F)
- E. Fire Hazard Classification: Provide materials that comply with Class A fire rating when tested in accordance with ASTM E84.
- F. Underwriters Laboratories approval: Provide materials that have been tested and approved by Underwriters Laboratories.
- G. Smoke Toxicity: Provide materials that have been tested for smoke toxicity and approved for use by New York City Materials and Equipment Acceptance Division (MEA).
- H. Fire Detection Characteristics: Provide materials that have been laboratory tested for the Early Warning Effect® in accordance with ASTM E 603. Submit test results certifying that when one square foot section of the material is heated to 300 degrees F, the wallcovering emits an odorless, colorless non-toxic vapor that will activate an ionization smoke detector.
- I. Low Emissions: Provide materials that meet the requirements of California Integrated Waste Management Board's Special Environmental Requirements Specification CA 01350 for low emitting materials.

#### 1.10 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver digitally printed vinyl wallcovering mural to the project site in unbroken and undamaged wrappings and clearly labeled with the manufacturer's identification label, quality or grade, UL label and sidemark.
- B. Store materials in a clean, dry storage area with temperature maintained above 55 degrees with normal humidity.
- C. Store material in a flat position to prevent damage to roll-ends. Do not cross stack material. Support material off the floor in a manner to prevent sagging and warping.

#### 1.11 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.
- B. Temperature and Humidity: Do not apply digitally printed wallcovering mural when surface and ambient temperatures are outside the temperature ranges required by the wallcovering manufacturer.
  - 1. Apply adhesive only when substrate surface temperature or ambient temperature is above 60 degrees F, or relative humidity is below 40 percent.
  - 2. Maintain constant recommended temperature and humidity for at least 72 hours prior to, throughout the installation period and for 72 hours after wallcovering installation completion.
- C. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.
  - 1. Provide not less than an 80 foot candles per square foot lighting level minimum measured mid height at substrate surfaces.
- D. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.
  - 1. Provide continuous ventilation and heating facilities to maintain substrate surface and ambient temperatures above 60 degrees F unless required otherwise by manufacturer's instructions.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates in accordance with test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: Comply with ASTM E84-13a; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: **25** or less = **15**
    - b. Smoke-Developed Index: **50** or less = **5**
    - c. 0-25 Flame Spread Index = Class A / Type I
  2. Fire-Growth Contribution: No flashover and heat and smoke release when tested in accordance with **NFPA 265**.
  3. IBC 803.2 exempts materials less than 0.036-inch- (0.9-mm-) thick applied directly to wall or ceiling surfaces from fire testing.
- B. Description: Provide wallpaper in rolls from same production run.
1. Compatibility with ASTM F793/F793M is preferred but not mandatory.
  2. Category: **I, Decorative**.
- C. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.
- D. Standard Method of Test for Surface Burning Characteristics of Building Materials per ASTM E84-13a:
1. ASTM E84 Test Data:
    - a. Flame Spread Index 15
    - b. Smoke Developed Index 5
  2. Classification: Class A
    - a. Fire retardancy: B-s1, d0 / Class A
  3. Adhesive: Adhesive for non-woven wallcovering like Arte Clearpro or 100% dispersion adhesive
  4. Light resistance: Good lightfastness
  5. Care: Spongeable during hanging (dab away damp glue)
  6. How to paste: Paste the wall
  7. How to remove: Strippable
  8. Remark: The pattern is repeatable, allowing several panoramiques to be joined together

## 2.2 CONTRACT VINYL –

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.



- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
  - 1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
  - 2. Plaster: Allow plaster to cure for at least 90 days. Neutralize areas of high alkalinity. Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
  - 3. Metals: If not factory primed, clean and apply metal primer as recommended in writing by metal-primer manufacturer and wall-covering manufacturer.
  - 4. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
  - 5. Painted Surfaces:
    - a. Check for pigment bleeding. Apply primer/sealer to areas susceptible to pigment bleeding as recommended in writing by primer/sealer manufacturer.
    - b. Sand gloss, semigloss, and eggshell finishes with fine sandpaper.
- D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

### 3.3 INSTALLATION OF WALL COVERING

- A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.
- B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
- D. Install wall covering without lifted or curling edges and without visible shrinkage.
- E. Match pattern above the finish floor.

- F. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.
- G. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

#### 3.4 CLEANING

- A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 72 00

## SECTION 097416 – FLEXIBLE WOOD VENEER WALLCOVERING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Provide Basis of Design - Arbor wood wallcovering, complete as specified as part of the contract documents.
- B. Related Sections
  - 1. Section 092900 - Gypsum Board: Wall Substrates.
  - 2. Section 099123 – Interior Painting: Preparation and priming of substrate.
  - 3. Section 064000 - Architectural Woodwork. Arbor to be single sourced from Koroseal so that millwork is from the same veneer flitch as the direct applied wallcovering.

#### 1.02 REFERENCES

- A. United States Testing Company, Inc.
  - 1. Testing performed "in accordance with the specification set forth in ASTM E84 "Standard Test Method for Surface Burning Characteristics of Building Materials," both as to equipment and test procedures. Test procedure is similar to UL-723, ANSI No. 2.5, NFPA No. 255 and UBC in UBC1994 & 1997.

#### 1.03 SUBMITTALS

- A. Submit manufacturer's product data and installation instructions for each type of wood veneer wallcovering, adhesive and accessory required.
  - 1. Include data on physical properties, fire hazard classification and fire detection characteristics of wallcoverings.
  - 2. Include manufacturer's recommendations for maximum permissible moisture content of substrates.
- B. Submit 6" X 9" samples of each type of wood wallcovering specified, inclusive of product name, wood species and cut and/or figure labeled on the back of each sample.
- C. Submit a copy of maintenance instructions to Owner in accordance with Division 1, Section "Contract Closeout."

1.04 QUALITY ASSURANCE

- A. Manufacturer: Provide each type of wood wallcovering required produced by one manufacturer whose published literature clearly indicated compliance of wood wallcovering with specified requirements.
- B. Applicator: Installation by skilled commercial wallcovering applicators with no less than three years of documented experience installing wallcovering of the types and extent specified for the project.
- C. Composition:
  - 1. A five-plywood wallcovering consisting of authentic wood veneer, bonded to paper, foil, glue line barrier, and paper.
  - 2. Factory applied protective urethane coating to ensure quality and help maintain the integrity of the wood veneer wallcovering.
- D. Fire Hazard Classification: Provide materials that comply with Class A Fire Rating when tested in accordance with ASTM E84.
  - 1. Flame Spread: 10
  - 2. Smoke Developed: 25
- E. Field Test Panels: Install not less than three (3) full-width sheets of each pattern specified in an area designated by the architect and or designer. Review installation area for conformance to manufacture's standard installation instructions. Maintain approved test area as part of the finished installation work and as a standard of comparison for the installation throughout the project.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver all wood wallcovering to the job site in the distributor's undamaged packaging clearly labeled and properly identified.
- B. Store materials in a clean, dry, protected area where temperature and humidity remain stable and within the ranges specified by the distributor.

1.06 PROJECT CONDITIONS

- A. Maintain a constant temperature range of 65 degrees F to 85 degrees F, with not more than 50% relative humidity and not less than the relative humidity specified for the project area in the AWI Quality Standards Section 1700-T-19, for at least 4 days prior to, throughout the installation period and maintained consistently thereafter.
- B. Surface preparation: Provide hanging surface that is smooth and free of all excess dust, oils, or other foreign matter.

- C. Select Surface Finish:
  - 1. Provide Gypsum board finish in compliance AWCI Specification, Level 4.
  - 2. Prepare wood composite surface: MDF or Hardwood as indicated in manufacturer's written installation instructions.
- E. Lighting: Provide permanent lighting during the installation process. If temporary lighting is required, provide not less than an 80-foot candles per square foot lighting level minimum measured mid-height at substrate surfaces.

#### 1.1. WARRANTY

- A. Submit distributor's 1-year written warranty against defects in material and workmanship. Koroseal Interior Products, LLC guarantees and warrants Arbor Flexible Wood Wallcovering to be free from defects in material and workmanship for a period of one year. Koroseal Interior Products, LLC's liability is limited to replacement of goods found by Koroseal Interior Products, LLC to be defective. This warranty is in lieu of all other warranties or guarantees expressed or implied, including warranties or guarantees of merchantability and fitness for a use.

#### 1.08 MAINTENANCE

- A. Replacement Materials: Provide between 2-5% of each species, cut and finish of wallcovering installed for maintenance/attic stock purposes. Furnish replacement materials from same production run as installed materials. Protect material with clearly marked packaging indicating product identification and project location.
- B. To clean, treat Arbor Flexible Wood Wallcovering as fine wood furniture using a lint-free cloth and Murphy's Oil Soap. Repeat this procedure once a year using Murphy's recommended instructions. *See detailed cleaning instructions under the Cleaning and Maintenance for Arbor document.*

### PART 2 - PRODUCTS

#### 2.01 DISTRIBUTOR

- A. Basis of Design: Arbor Wood Veneer Wallcovering, distributed by Koroseal Interior Products, LLC, Fairlawn, OH. Contact Sales Representative: Name: Daphne Donaldson Phone: (205)-510-8602, [ddonaldson@koroseal.com](mailto:ddonaldson@koroseal.com).

#### 2.02 MATERIALS

- A. Wallcovering: Arbor Wood Wallcovering, "AA" Architectural Grade, Flexible Wood Veneer Wallcovering. A five-ply *pre-finished urethane* wood wallcovering consisting of authentic wood veneer, bonded to paper, foil, glue line barrier, and paper.
  - 1. Species/Pattern: Select: Standard: Walnut, Recon Urban and Maple.

2. Cut and Figure: Select: Quarter Cut, Plank - Recon
3. Matching: Select: Book Match
4. Flitch Number: To be submitted and approved before ordering.
5. Sheet Size: 4' x 10' or 4' x 8'
6. Factory Finish: Select: Standard and Ultra 70, see finish schedule.

### 2.03 ACCESSORIES

#### A. Adhesive:

1. Roman Decorating Products: Extra Strength Pro-732, Clay Strippable Pro-774
2. Gardner-Gibson Products: Dynamite 111 Heavy Duty Clay
3. Gardner-Gibson Products: Dynamite 433 Heavy-Duty Clay Strippable

#### B. Substrate Primer/Sealer: Acrylic base primer specifically formulated for use with flexible wood veneer wallcovering. *No Oil Based Primers is to be used in the installation of Arbor Wood Wallcovering.*

1. Romans Decorating Products: Pro-935 (R 35), Pro-977
2. Zinsser Company Products: Bulls Eye 1-2-3 Primer Sealer, Shieldz Universal Plus Primer, Gardz High Performance Sealer

## PART 3 – EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates and installation conditions.
- B. Test substrates with suitable moisture meter and verify that moisture content does not exceed 7%.
- C. Verify that substrate surfaces are clean, dry, smooth, structurally sound, and free from surface defects and imperfections that would show through the finished surface.
- D. Notify the contractor and architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- E. Do not proceed with work until conditions have been corrected.

### 3.02 INSTALLATION

- A. Install wood veneer wall coverings in strict accordance with manufacturer's written installation instructions.
- B. After the application of three sheets of wood wallcovering, request inspection by Architect/Designer for material quality and proper installation.
- C. If problems occur, stop the installation, and contact the local Arbor Wood Veneer Wallcovering Sales Representative before proceeding.
- D. Install each sheet in sequential, numerical order, as printed on the back of each sheet.
- E. Install as delivered from the factory with the standard urethane finish applied by the manufacturer.
- F. Field applied stains and finishes void all Fire Ratings and the manufacturer's written warranty.

### 3.03 CLEAN-UP COMPLETION

- A. Upon completion of the work, remove excess materials, debris and rubbish resulting from the installation and leave the area in a clean and orderly condition.
- B. Protect the finished wood wallcovering from damage that may occur from other trades until project has been completed.

END OF SECTION 097416

SECTION 097720 - DECORATIVE FIBERGLASS REINFORCED WALL PANELS (FRP)

**SUMMARY**

- A. Section Includes: Prefinished polyester glass reinforced plastic sheets and adhered to unfinished gypsum wallboard.
  - 1. PVC trim.
- B. Products Not Furnished or Installed under This Section:
  - 1. Gypsum substrate board.
  - 2. Resilient Base.
  - 3. Porcelain or Ceramic Tile Bases

1.2 RELATED SECTIONS

- A. Section 09269 - Gypsum Board Assemblies
- B. Section 09900 - Painting
- C. Section 09650 - Resilient Flooring & Base.

1.3 REFERENCES

- A. American Society for Testing and Materials: Standard Specifications (ASTM)
  - 1. ASTM D 256 - Izod Impact Strengths (ft #/in)
  - 2. ASTM D 570 - Water Absorption (%)
  - 3. ASTM D 638 - Tensile Strengths (psi) & Tensile Modulus (psi)
  - 4. ASTM D 790 - Flexural Strengths (psi) & Flexural Modulus (psi)
  - 5. ASTM D 2583- Barcol Hardness
  - 6. ASTM D 5319 - Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels.
  - 7. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Product Data: Submit sufficient manufacturer's data to indicate compliance with these specifications, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- B. Shop Drawings: Submit elevations of each wall showing location of paneling and trim members with respect to all discontinuities in the wall elevation.
- C. Selection Samples: Submit manufacturer's standard color pattern selection samples representing manufacturer's full range of available colors and patterns.
- D. Samples for Verification: Submit appropriate section of panel for each finish selected indicating the color, texture, and pattern required.
  - 1. Submit complete with specified applied finish.
  - 2. For selected patterns show complete pattern repeat.
  - 3. Exposed Molding and Trim: Provide samples of each type, finish, and color.



- E. Manufacturers Material Safety Data Sheets (MSDS) for adhesives, sealants and other pertinent materials prior to their delivery to the site.

## 1.5 QUALITY ASSURANCE

- A. Conform to building code requirements for interior finish for smoke and flame spread requirements as tested in accordance with:
  - 1. ASTM E 84 (Method of test for surface burning characteristics of building Materials)
    - a. Wall Required Rating – Class [A] [C].
- B. Sanitary Standards: System components and finishes to comply with:
  - 1. United States Department of Agriculture (USDA) requirements for food preparation facilities, incidental contact.
  - 2. Food and Drug Administration (FDA) 1999 Food Code 6-101.11.
  - 3. Canadian Food Inspection Agency (CFIA) requirements.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials factory packaged on strong pallets.
- B. Store panels and trim lying flat, under cover and protected from the elements. Allow panels to acclimate to room temperature (range of 60 to 75°F) for 48 hours prior to installation.

## 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Building are to be fully enclosed prior to installation with sufficient heat (70°) and ventilation consistent with good working conditions for finish work
- B. During installation and for not less than 48 hours before, maintain an ambient temperature and relative humidity within limits required by type of adhesive used and recommendation of adhesive manufacturer.
  - 1. Provide ventilation to disperse fumes during application of adhesive as recommended by the adhesive manufacturer.

## 1.8 WARRANTY

- A. Furnish one-year guarantee against defects in material and workmanship.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURER

- A. Basis of Design: Marlite; 1 Marlite Drive, Dover, OH 44622. 800-377-1221 FAX (330) 343-4668 Email: [info@marlite.com](mailto:info@marlite.com) [www.marlite.com](http://www.marlite.com).
- B. Product:
  - 1. Standard FRP

### 2.2 PANELS

- A. Fiberglass reinforced thermosetting polyester resin panel sheets complying with ASTM D 5319.
  - 1. Coating: Multi-layer print, primer and finish coats or applied over-layer.

2. Dimensions:
    - a. Thickness – 0.090“(2.29mm) nominal
    - b. Width - 4'-0” (1.22m) nominal
    - c. Length –As indicated on the drawings
  3. Tolerance:
    - a. Length and Width: +/-1/8 “(3.175mm)
    - b. Square - Not to exceed 1/8 “for 8-foot (2.4m) panels or 5/32 “(3.96mm) for 10-foot (2.4m) panels
- B. Properties: Resistant to rot, corrosion, staining, denting, peeling, and splintering.
1. Flexural Strength -  $1.0 \times 10^4$  psi per ASTM D 790. (7.0 kilogram-force/square millimeter)
  2. Flexural Modulus -  $3.1 \times 10^5$  psi per ASTM D 790. (217.9 kilogram-force/square millimeter)
  3. Tensile Strength -  $7.0 \times 10^3$  psi per ASTM D 638. (4.9 kilogram-force/square millimeter)
  4. Tensile Modulus -  $1.6 \times 10^5$  psi per ASTM D 638. (112.5 kilogram-force/square millimeter)
  5. Water Absorption - 0.72% per ASTM D 570.
  6. Barcol Hardness (scratch resistance) of 35 55 as per ASTM D 2583.
  7. Izod Impact Strength of 72 ft. lbs./in ASTM D 256
- C. Back Surface: Smooth. Imperfections which do not affect functional properties are not cause for rejection.
- D. Front Finish: As Indicated on the FINISH SCHEDULE & LEGEND
- a. Color:
    - 1) Marlite Standard FRP is available in a variety of colors, including;
      - a) P100 White
  - b. Fire Rating Class A (I)
  - c. Size: standard sizes are;
    - 1) Marlite FRP / Symmetrics / Artizan / Envue
      - a) 48” x 96” [1.2m x 2.4m] x .090” (3mm) nom.
      - b) 48” x 108” [1.2m x 2.7m] x .090” (3mm) nom.
      - c) 48” x 120” [1.2m x 3m] x .090” (3mm) nom.

## 2.3 MOLDINGS

- A. PVC Trim: Thin-wall semi-rigid extruded PVC.
1. M 350 Inside Corner, [8' length] [10' length]
  2. M 360 Outside Corner, [8' length] [10' length]
  3. M 365 Division, [8' length] [10' length]
  4. M 370 Edge, [8' length] [10' length]
  5. V 177 135° Inside Corner [8' length] [White only]
  6. V 179 135° Outside Corner [8' length] [White only]
  7. Color: White

## 2.4 ACCESSORIES

- A. Fasteners: Non-staining nylon drive rivets.

1. Match panel colors.
  2. Length to suit project conditions.
- B. Adhesive: Either of the following construction adhesives complying with ASTM C 557.
1. Marlite C-551 FRP Adhesive - Water- resistant, non-flammable adhesive.
  2. Marlite C-915 Construction Adhesive - Flexible, water-resistant, solvent based adhesive, formulated for fast, easy application.
  3. Titebond Advanced Polymer Panel Adhesive – VOC compliant, non-flammable, environmentally safe adhesive.
- C. Sealant:
1. Marlite Brand MS-250 Clear Silicone Sealant.
  2. Marlite Brand MS-251 White Silicone Sealant.
  3. Marlite Brand - Color Match Sealant.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Examine backup surfaces to determine that corners are plumb and straight, surfaces are smooth, uniform, clean and free from foreign matter, nails countersunk, joints and cracks filled flush and smooth with the adjoining surface.
1. Verify that stud spacing does not exceed 24” (61cm) on-center.
- B. Repair defects prior to installation.
1. Level wall surfaces to panel manufacturer’s requirements. Remove protrusions and fill indentations.

#### 3.2 INSTALLATION

- A. Comply with manufacturer's recommended procedures and installation sequence.
- B. Cut sheets to meet supports allowing 1/8” (3 mm) clearance for every 8 foot (2.4m) of panel.
1. Cut and drill with carbide tipped saw blades or drill bits or cut with shears.
  2. Pre-drill fastener holes 1/8” (3mm) oversize with high speed drill bit.
    - a. Space at 8” (200mm) maximum on center at perimeter, approximately 1” from panel edge.
    - b. Space at in field in rows 16’ (40.64cm) on center, with fasteners spaced at 12” (30.48 cm) maximum on center.
- C. Apply panels to board substrate, above base, vertically oriented with seams plumb and pattern aligned with adjoining panels.
1. Install panels with manufacturer's recommended gap for panel field and corner joints.
    - a. Adhesive trowel and application method to conform to adhesive manufacturer’s recommendations.
    - b. Drive fasteners for snug fit. Do not over-tighten.
- D. Apply panel moldings to all panel edges using silicone sealant providing for required clearances.
1. All moldings must provide for a minimum 1/8 “(3mm) of panel expansion at joints and edges, to insure proper installation.
  2. Apply sealant to all moldings, channels and joints between the system and different materials to assure watertight installation.

- A. Remove excess sealant from panels and moldings. Wipe panel down using a damp cloth and mild soap solution or cleaner.
- B. Refer to manufacturer's specific cleaning recommendations Do not use abrasive cleaners.

END OF SECTION

## SECTION 099113 - EXTERIOR PAINTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
  - 1. Steel.
  - 2. Galvanized metal.
- B. Related Requirements:
  - 1. Section 099123 "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
  - 3. VOC content.

#### 1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
  - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. Colors: As indicated in Section 090690 color schedule.

2.2 PRIMERS/SEALERS

- A. Primer, Alkali Resistant, Water Based: MPI #3.

2.3 METAL PRIMERS

- A. Primer, Alkyd, Anti-Corrosive for Metal: MPI #79.
- B. Primer, Galvanized, Water Based: MPI #134.

2.4 WATER-BASED PAINTS

- A. Latex, Exterior Low Sheen (Gloss Level 3-4): MPI #15.
- B. Light Industrial Coating, Exterior, Water Based, Semi-Gloss (Gloss Level 5): MPI #163.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

#### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
  - 1. SSPC-SP 3, "Power Tool Cleaning."
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by

mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  - 3. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

### 3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.5 EXTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
  - 1. Water-Based Light Industrial Coating System:
    - a. Prime Coat: Primer, alkyd, anti-corrosive for metal, MPI #79.



- b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
- c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5), MPI #163.

B. Galvanized-Metal Substrates:

1. Water-Based Light Industrial Coating System:

- a. Prime Coat: Primer, galvanized, water based, MPI #134.
- b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
- c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5), MPI #163.

END OF SECTION 099113

## SECTION 099123 - INTERIOR PAINTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
  - 1. Steel.
  - 2. Gypsum board.
- B. Related Sections include the following:
  - 1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
  - 2. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

#### 1.3 QUALITY ASSURANCE

- A. MPI Standards:
  - 1. Products: Complying with MPI standards indicated and listed in "MPI Approved

Products List."

2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  1. Maintain containers in clean condition, free of foreign materials and residue.
  2. Remove rags and waste from storage areas daily.

#### 1.5 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

#### 1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
  1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Benjamin Moore & Co.
  2. ICI Paints.
  3. Kelly-Moore Paints.
  4. PPG Architectural Finishes, Inc.
  5. Sherwin-Williams Company (The).

#### 2.2 PAINT, GENERAL

- A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
  2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
  3. Flat Topcoat Paints: VOC content of not more than 50 g/L.
  4. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
  5. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
  6. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
- C. Colors: As indicated in Section 090690 Color Schedule.

## 2.3 PRIMERS/SEALERS

- A. Primer, Alkali Resistant, Water Based: MPI #3.
- B. Interior Latex Primer/Sealer: MPI #50.

## 2.4 METAL PRIMERS

- A. Quick-Drying Alkyd Metal Primer: MPI #76.

## 2.5 LATEX PAINTS

- A. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
- B. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
  2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
  1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
- E. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
  1. Use applicators and techniques suited for paint and substrate indicated.
  2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

### 3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.5 INTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
  - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    - a. Prime Coat: Quick-drying alkyd metal primer.
    - b. Intermediate Coat: Interior latex matching topcoat.
    - c. Topcoat: Interior latex (semigloss).
- B. Gypsum Board Substrates:
  - 1. Latex System: MPI INT 9.2A.
    - a. Prime Coat: Interior latex primer/sealer.
    - b. Intermediate Coat: Interior latex matching topcoat.
    - c. Topcoat: Interior latex (eggshell).

END OF SECTION 099123

***DIVISION 10***  
***SPECIALTIES***

## SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cast dimensional characters.
  - 2. Cutout dimensional characters.

#### 1.3 DEFINITIONS

#### 1.4 COORDINATION

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
  - 3. Show locations of electrical service connections.
  - 4. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
  - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
  - 1. Dimensional Characters: Half-size Sample each type of dimensional character.
  - 2. Exposed Accessories: Half-size Sample of each accessory type.



3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.

E. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

F. Delegated-Design Submittal: For **[signs indicated in "Performance Requirements" Article]**

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Sample Warranty: For special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

#### 1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products.

#### 1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.

#### 1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.

b. Separation or delamination of sheet materials and components.

2. Warranty Period: [Five] years from date of Substantial Completion.

## 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
  - 1. Uniform Wind Load: As indicated on Structural Drawings
  - 2. Concentrated Horizontal Load: As indicated on Structural Drawings
  - 3. Other Design Load: As indicated on Structural Drawings
  - 4. Uniform and concentrated loads need not be assumed to act concurrently.
- B. Thermal Movements: For exterior fabricated channel dimensional characters allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: [120 deg F (67 deg C), ambient; 180 deg F (100 deg C),
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.2 DIMENSIONAL CHARACTERS

- A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, dimensional character sign type(s) as shown at each individual building and at the campus monument and as follows:
  - 1. Character Material: Cast Aluminum
  - 2. Character Height: As indicated on Drawings
  - 3. Thickness: Manufacturer's standard for size of character
  - 4. Finishes: Clear anodized
  - 5. Mounting: [As indicated on Drawings] [Concealed studs] [Projecting studs] [Rosette-head through fasteners] [Countersunk flathead through fasteners]
  - 6. Typeface: CENTURY GOTHIC at each individual exterior building signage  
**FRANKLIN GOTHIC HEAVY** at the campus monument sign

## 2.3 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- B. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- C. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316, stretcher-leveled standard of flatness.

- E. Zinc Castings: ASTM B 240, alloy and temper recommended by sign manufacturer for type of use and finish indicated.
- F. Zinc Sheet: ASTM B 69 alloy and temper recommended by sign manufacturer for type of use and finish indicated.
- G. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- H. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

## 2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
  - 1. Use concealed fasteners and anchors unless indicated to be exposed.
  - 2. For exterior exposure, furnish stainless-steel (appropriate to cast metal letter) devices unless otherwise indicated.
  - 3. Exposed Metal-Fastener Components, General:
    - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    - b. Fastener Heads: For nonstructural connections, use **flathead or oval countersunk** screws and bolts with tamper-resistant **Allen-head** slots unless otherwise indicated.
  - 4. Sign Mounting Fasteners:
    - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

## 2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
  2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
  3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
  4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
  5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
  6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
  7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match sign-background color unless otherwise indicated.
  2. Stainless-Steel Brackets: Factory finish brackets to match sign background finish unless otherwise indicated.

## 2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

- A. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that electrical service is correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
  - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
  - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
  - 2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until

spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.

- b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate and install washers and nuts on stud ends projecting through opposite side of surface and tighten.
3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position and push to engage tape adhesive.

### 3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

## SECTION 101423 - PANEL SIGNAGE

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Room-identification signs.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

- a. and distance to Project for each regionally manufactured material.

2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.

B. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Room-Identification Signs: Full-size Sample.

D. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

#### 1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

#### 1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in

materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Deterioration of finishes beyond normal weathering.
  - b. Deterioration of embedded graphic image.
  - c. Separation or delamination of sheet materials and components.
2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PANEL SIGNS, GENERAL

- A. Regional Materials: Panel signs shall be manufactured within **500 miles** of Project site.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities for signs.

### 2.3 SIGNS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated by the following:
  1. In Pro Architectural Signage
  2. 2/90 Sign Systems.
- B. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
  1. Structural rails shall be 6063-T5 extruded aluminum in accordance with ASTM B 221 and ASTM B 209. The rail shall be the internal horizontal member spaced to allow uniform, modular sizing of inserts, anodized black. The rail shall be capable of accepting plastic or aluminum copy inserts. Rail shall allow for different mounting devices, including wall mounting for screw-on applications and pressure sensitive tape. Rail joiners shall be extruded in black PVC plastic. Rail joiners shall connect structural rails together providing a butt joint along their edges. Rail joiners shall not be visible in rail assembly.
  2. Solid copy inserts shall be 0.090 inch extruded ABS plastic core with 0.003 inch acrylic cap bonded during the extrusion/ texturing process.
  3. Braille dots shall conform to standard dimensions for Grade 2 Braille: Dot diameter: 0.059 inch; Dot height: 0.025 inch; Inter-dot spacing: 0.090 inch; Horizontal separation between cells: 0.241 inch; Vertical separation between cells: 0.395 inch.
  4. End caps shall be 6063-T5 extruded aluminum, with square corners. End caps shall interlock to structural rail with steel spring clips to form an integral unit, enclosing and



securing the changeable copy inserts, without requiring tools for assembly. End caps shall be interchangeable to either end of sign and to other signs in the system of equal height.

5. Top/bottom trim shall be extruded in 6063-T5 aluminum, anodized black, to provide decorative trim cap, which butts flush to adjacent copy insert and encloses top or bottom of structural rail and copy insert.
6. Mounting: Surface mounted to wall with two-face tape.
7. Text and Typeface: Accessible raised characters and Braille, Arial.

## 2.4 ACCESSORIES

- A. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

## 2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
  2. Form work to required shapes and sizes, with true curves, lines and angles. Provide necessary rebates, lugs and brackets for assembly of units.
  3. Contact surfaces of connected members shall be true. Assemble so joints will be tight and practically unnoticeable, without use of filling compound.
  4. Signs shall have fine, even texture and be flat and sound. Lines and miters shall be sharp, arises unbroken, profiles accurate and ornament true to pattern. Plane surfaces shall be smooth, flat and without oil-canning, free of rack and twist. Maximum variation from plane of surface shall be plus or minus 0.032 inch. Restore texture to filled or cut areas.
  5. Extruded members shall be free from extrusion marks. Square turns and corners shall be sharp, curves true.
  6. Exposed ends and edges shall be mill smooth, with corners slightly rounded.
  7. All painted surfaces shall be properly primed. Finish coating of paint shall have complete coverage with no light or thin applications allowing substrate or primer to show. Parts shall be checked for approval against the color match master chip. Finished surface shall be smooth, free of scratches, gouges, drips, bubbles, thickness variations, foreign matter and other imperfections.

## 2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long

dimension of finished trim or border surface unless otherwise indicated.

## 2.7 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
  - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated.
- C. Mounting Methods:
  - 1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

### 3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423

## SECTION 102113.19 - PLASTIC TOILET COMPARTMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Solid-plastic toilet compartments configured as toilet enclosures and urinal screens.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for blocking.
2. Section 092216 "Non-Structural Metal Framing" for blocking.
3. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

#### 1.2 COORDINATION

- A. Coordinate requirements for blocking, reinforcing, and other supports concealed within wall.

#### 1.3 ACTION SUBMITTALS

A. Product Data:

1. Solid-plastic toilet compartments:
  - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings: For solid-plastic toilet compartments.

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.

C. Samples for Verification: Actual sample of finished products for each type of toilet compartment indicated.

1. Size: 6-inch- (152-mm-) square, of same thickness indicated for Work.
2. Include each type of hardware and accessory.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and pre-consumer recycled content and cost.

#### 1.4 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.
- B. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site.
- C. Regulatory Requirements: Comply with applicable provisions in the U.S. Department of Justice "2010 ADA Standards for Accessible Design" and ICC A117.1 for toilet compartments designated as accessible.

#### 2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, no-sightline system, and with homogenous color and pattern throughout thickness of material.
  1. Color and Pattern: One color and pattern in each room as selected by Architect from manufacturer's full range.
- B. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- C. Brackets (Fittings):
  1. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum.

#### 2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories, Standard Duty: Manufacturer's standard operating hardware and accessories.
  1. Material: Clear-anodized aluminum.
  2. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.

3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit, designed for emergency access, and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
  4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
  5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
  6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with anti-grip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

## 2.4 MATERIALS

- A. Aluminum Extrusions: ASTM B221 (ASTM B221M).
- B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

## 2.5 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
  - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF PLASTIC TOILET COMPARTMENTS

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
  - 1. Maximum Clearances:
    - a. Pilasters and Panels: 1/2 inch (13 mm).
    - b. Panels and Walls: 1 inch (25 mm).
  - 2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
    - a. Locate bracket fasteners, so holes for wall anchors occur in masonry or tile joints.
    - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels and adjust, so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

### 3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.19

## SECTION 102600 - WALL AND DOOR PROTECTION

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Corner guards.
2. Partition end cap guards.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.
- B. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
  1. Corner Guards: 12 inches (300 mm) long.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Material Test Reports: For each impact-resistant plastic material.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated. Refer to Section 014000 "Quality Requirements."



- D. Revise subparagraph below to suit Project.
  - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
  - 1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.

#### 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures.
  - 2. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Stainless-Steel Sheet: ASTM A 240/A 240M.
- B. Fasteners: Nonmagnetic stainless-steel screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- C. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer and with

a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.2 CORNER GUARDS

A. Surface-Mounted, Metal Corner Guards: Fabricated from one-piece, formed metal with formed edges; with 90-degree turn to match wall condition.

1. Material: Stainless steel, Type 304.
  - a. Thickness: Minimum 0.0500 inch (1.3 mm).
  - b. Finish: Directional satin, No. 4.
2. Wing Size: Nominal 2-1/2 by 2-1/2 inches (65 by 65 mm).
3. Corner Radius: 1/8 inch (3 mm).
4. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.
5. Height: Full Wall Height

B. Surface-Mounted, Metal Partition End Cap Guard: Fabricated from one-piece, formed metal with formed edges, with 90-degree turn(s) to match wall condition.

1. Material: Stainless steel, Type 304.
  - a. Thickness: Minimum 0.0500 inch (1.3 mm).
  - b. Finish: Directional satin, No. 4
2. Wing Size: Nominal 3-1/2 inch (88.9 mm).
3. Corner Radius: 1/8 inch (3 mm).
4. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.

## 2.3 IMPACT-RESISTANT WALL COVERINGS

A. Impact-Resistant Sheet Wall Covering: Fabricated from plastic sheet wall-covering material.

## 2.4 FABRICATION

- A. Fabricate impact-resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.
- B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

## 2.5 METAL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Remove tool and die marks and stretch lines, or blend into finish.
  - 2. Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 3. Run grain of directional finishes with long dimension of each piece.
  - 4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.

- B. Before installation, clean substrate to remove dust, debris, and loose particles.

### 3.3 INSTALLATION

- A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
  - 1. Install impact-resistant wall protection units in locations and at mounting heights indicated on Drawings.
  - 2. Provide mounting hardware, anchors, and other accessories required for a complete installation.
    - a. Provide anchoring devices to withstand imposed loads.

### 3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

END OF SECTION 102600

## SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Custodial accessories.

B. Related Sections:

1. Section 088300 "Mirrors" for frameless mirrors.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

#### 1.5 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

## 1.6 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

### 2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. A & J Washroom Accessories, Inc.
  - 2. Bobrick Washroom Equipment, Inc.
  - 3. Bradley Corporation.
  - 4. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
- B. Toilet Tissue (Roll) Dispenser: **Owner Furnished Contractor Installed**
- C. Combination Towel (Folded) Dispenser/Waste Receptacle: **Owner Furnished Contractor Installed**

- D. Liquid-Soap Dispenser: **Owner Furnished Contractor Installed**
- E. Grab Bar:
  - 1. Basis-of-Design Product: Bobrick B-5806.
  - 2. Mounting: Flanges with concealed fasteners.
  - 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
    - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
  - 4. Outside Diameter: 1-1/4 inches (32 mm).
  - 5. Configuration and Length: As indicated on Drawings.
- F. Sanitary-Napkin Disposal Unit: **Owner Furnished Contractor Installed**
- G. Seat-Cover Dispenser: **Owner Furnished Contractor Installed**

## 2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. A & J Washroom Accessories, Inc.
  - 2. Bobrick Washroom Equipment, Inc.
  - 3. Bradley Corporation.
  - 4. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
- B. Shower Curtain Rod:
  - 1. Basis-of-Design Product: Bobrick B-6047.
  - 2. Description: 1-1/4-inch (32-mm) OD; fabricated from nominal 0.05-inch- (1.3-mm-) thick stainless steel.
  - 3. Mounting Flanges: Stainless-steel flanges designed for exposed fasteners.
  - 4. Finish: No. 4 (satin).
- C. Shower Curtain:
  - 1. Basis-of-Design Product: Bobrick B-204-2 and B-204-3.
  - 2. Size: Minimum 6 inches (152 mm) wider than opening by 72 inches (1828 mm) high.
  - 3. Material: Vinyl, minimum 0.006 inch (0.15 mm) thick, opaque, matte.
  - 4. Color: White.
  - 5. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
  - 6. Shower Curtain Hooks: Stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

## 2.4 CUSTODIAL ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. A & J Washroom Accessories, Inc.
2. Bobrick Washroom Equipment, Inc.
3. Bradley Corporation.
4. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.

B. Mop and Broom Holder:

1. Basis-of-Design Product: Bobrick B-224.
2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 36 inches (914 mm).
4. Hooks: Three.
5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, No. 4 finish (satin).
  - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
  - b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

END OF SECTION 102800



## SECTION 104413 - FIRE PROTECTION CABINETS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Fire-protection cabinets for the following:
    - a. Portable fire extinguishers.
- B. Related Requirements:
  - 1. Section 104416 "Fire Extinguishers."

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed, semi-recessed, or surface-mounting method and relationships of box and trim to surrounding construction.
- B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers, indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

## PART 2 - PRODUCTS

### 2.1 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. JL Industries, Inc.; a division of the Activar Construction Products Group.
    - b. Larsens Manufacturing Company.
    - c. Potter Roemer LLC.
- B. Cabinet Construction: Nonrated.
- C. Cabinet Material: Cold-rolled steel sheet.
- D. Recessed Cabinet:
  - 1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
- E. Semi-recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
  - 1. Rolled-Edge Trim: **2-1/2-inch** backbend depth.
- F. Cabinet Trim Material: Steel sheet.
- G. Door Material: Steel sheet.
- H. Door Style: Vertical duo panel with frame.
- I. Door Glazing: Tempered float glass (clear).
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
  - 1. Provide projecting door pull and friction latch.
  - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- K. Accessories:
  - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers

indicated, with plated or baked-enamel finish.

L. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
  - a. Finish: Baked enamel or powder coat.
  - b. Color: White.
2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
  1. Weld joints and grind smooth.
  2. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
  1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum **1/2 inch** thick.
  2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.3 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

#### 3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
  - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semi-recessed fire-protection cabinets.

#### 3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

## SECTION 104416 - FIRE EXTINGUISHERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers.
- B. Related Requirements:
  - 1. Section 104413 "Fire Protection Cabinets."

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure of hydrostatic test according to NFPA 10.
    - b. Faulty operation of valves or release levers.
  - 2. Warranty Period: Six years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

### 2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Amerex Corporation.
    - b. Ansul Incorporated.
    - c. JL Industries, Inc.; a division of the Activar Construction Products Group.
    - d. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
    - e. Larsens Manufacturing Company.
    - f. Potter Roemer LLC.
  - B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:80-B:C, **10-lb** nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
  - C. Wet-Chemical Type: UL-rated 2-A:1-B:C:K, 1.6-gal. (6-L) nominal capacity, with potassium acetate-based chemical in stainless-steel container; with pressure-indicating gage.

### 2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

## SECTION 105020 – METAL CANOPIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Building supported, pre-engineered metal canopies including fascia channels, decking, tension / overhead hanger rods, and attachment hardware.
  2. Post supported, pre-engineered metal canopies including fascia channels, decking, post, beams, gutters, downspouts and attachment hardware.
  - 3.
- B. Related Sections:
1. Division 01: Administrative, procedural, and temporary work requirements.
  2. Flashing of various designs may be required. Generic flashing supplied by Manufacturer. Specialty flashing to be supplied by installer.
  3. Determine wall construction, make-up and thickness for building supported canopies.
  4. Ensure adequate wall condition to carry canopy loads where required.
  5. Concrete for canopy footings. Footing block-outs for post-supported units provided by manufacturer to be installed as part of concrete work.
  6. Consider water drainage away from canopy where necessary.
  7. Any necessary removal or relocation of existing structures, obstructions or materials.

#### 1.2 REFERENCES

- A. Aluminum Association (AA)DAF 45 - Designation System for Aluminum Finishes.
- B. American Architectural Manufacturers Association (AAMA)
1. 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Architectural Extrusions and Panels.
- C. American Society of Civil Engineers (ASCE) 7 - Minimum Design Loads for Buildings and Other Structures.
- D. ASTM International (ASTM)
1. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  2. B429 - Standard Specification for Aluminum-Alloy Extruded Pipe and Tube.

#### 1.3 SYSTEM DESCRIPTION

- A. Design Requirements: Design canopy system to withstand:
1. Standards for wind pressure, snow load, and drifting snow load in accordance with current adopted form of the International Building Code or accepted requirements of local municipality. Refer to Structural Drawings and specifications for required design and wind load requirements.



#### 1.4 SUBMITTALS

##### A. Submittals for Review:

1. Shop Drawings: Indicate system components, dimensions, attachments, and accessories for each canopy type. Shop drawings shall be stamped and signed by a licensed engineer in this State.
2. Calculations for each canopy type shall be stamped and signed by a licensed engineer in this State.
3. Samples:
  - a. 3 x 3-inch coating samples in specified color.
  - b. 6-inch-long fascia extrusion sample showing profile and standard finish.
  - c. 6-inch decking samples showing profile and standard finish.

#### 1.5 QUALITY ASSURANCE

- ##### A. Installer Qualifications: Minimum 5 years experience in installation of products.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURER

- ##### A. Mapes Canopies: Super Lumideck HR Hanger Rod Supported & Free Standing (basis of design) Lincoln, Nebraska Phone: 1-888-273-1132. Fax: 1-877-455-6572.
- ##### B. MASA Architectural: Extrudeck Series Canopies 21 Randolph Ave. Avenel, NJ 07001 800-761-7446 [www.architecturalcanopies.com](http://www.architecturalcanopies.com).
- ##### C. Tennessee Valley Metals Inc.

#### 2.2 MATERIALS

- ##### A. Aluminum Extrusions:
1. ASTM B221& ASTM B429 6063-T5 alloy and temper.
- ##### B. Hardware:
1. All fasteners shall be (stainless steel) or (zinc coated) for corrosion resistance.

#### 2.3 COMPONENTS

- ##### A. Framing:
1. Type: Extruded aluminum "J" channel fascia
  2. Size: 8" x .125"
- ##### B. Canopy Supports: Extruded Aluminum Canopy Support "I" Beam
- ##### C. Decking: 3" x 6" Interlocking Extruded aluminum flat soffit decking
- ##### D. Post: 4" x 4" Extruded Aluminum post (with post hole drainage)

- E. Beams: 4" x 7" Extruded Aluminum beams
- F. Attachment building supported canopy: 1.050" diameter steel hanger rod (finished to match canopy) with clevis ends and stainless steel bolts.
- G. Other Components: other components as indicated or as required for system attachment and performance.

## 2.4 ACCESSORIES

- A. Lighting (Surface Mount) Type with welded light dams (see electrical for Light Fixtures)
- B. Down spouts 2" x 3" (.032 roll formed) (.125 Heavy Extruded) Finished to match canopy color.

## 2.5 FABRICATION

- A. Fabricate canopy system in accordance with approved Shop Drawings.
- B. Kit canopies to be mechanically assembled with shear stress strength as per engineering. Pre-assembled canopies are shop welded by manufacturer's approved personnel.
- C. All connections shall be mechanically assembled utilizing 3/16 fasteners with a minimum shear stress of 350 lb. Pre-welded or factory-welded connections are not acceptable.
- D. Drainage system to be concealed type. Covered surfaces direct water to field drilled drain, to be *coordinated at site*. Water shall drain from covered surfaces into intermediate trough and be directed to Front Scuppers at building supported canopies. Water shall drain from covered surfaces into integral gutter beams and be directed to ground level discharge via one or more designated support posts.
- E. Support columns and gutter beams shall be designed such that the columns will be notched to a "saddle" that will receive and secure the gutter beams.
- F. Decking shall be designed with interlocking extruded aluminum members with mechanical fasteners field applied to provide structural integrity for the completed assembly

## 2.6 FINISHES

- A. Fluoropolymer Kynar 500 finish, AAMA 2605, two coats, color to be selected by architect from manufacturer's standard and custom color range.

## PART 3 - EXECUTION

### 3.1 FIELD DIMENSIONS

- A. Field verify dimensions of supporting structure at site of installation prior to fabrication.
- B. Confirm that surrounding area is ready for the canopy installation.
- C. Installer shall confirm dimensions and elevations to be as shown on drawings provided by Manufacturer.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Install components plumb and level, in proper plane, free from warp and twist.
- C. Anchor system to building components; provide adequate clearance for movement caused by thermal

expansion and contraction and wind loads.

### 3.3 ADJUSTING

- A. Touch up minor scratches and abrasions on finished surfaces to match original finish.
- B. Clean with mild, non-abrasive solution and a cotton cloth under lowpressure.

END OF SECTION

## SECTION 105030 TURNOUT GEAR LOCKERS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Design, fabrication and installation of wall mounted turnout gear lockers as specified herein.

#### 1.2 RELATED SECTIONS

- A. Division 00 Section "ARRA Grant Requirements" for "The Buy American Act" requirements as applicable.
- B. Section 10: Metal Lockers.
- C. Sections of Division 16: electrical as applicable.

#### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions.
- B. Shop Drawings: Submit manufacturer's shop drawings for each individual run of lockers.
- C. Samples: Submit manufacturer's standard color samples.
- D. Owner's Manual: Provide maintenance manual at closeout.
- E. Warranty: Submit manufacturer's standard warranty.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of fifteen years experience in the direct manufacture of lockers.
- B. Installer Qualifications: Installer shall have experience necessary to assure lockers are installed properly and according to manufacturer's instructions.
- C. Reference:
  - 1. ASTM A513 – Minimum properties of Electric-Resistance-Welded Carbon Allow Steel Mechanical Tubing
  - 2. ASTM A510 - Minimum properties of Wire Rods and Coarse Round Wire, Carbon Steel and Alloy Steel

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers with labels identifying product and manufacturer's name.

- B. Storage: Store materials in a clean dry area.
- C. Handling: Protect materials and finish during installation and handling to prevent damage.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

- A. Basis of Design Manufacturers: Subject to compliance with requirements of the contract documents, acceptable manufacturer's are as follows:
  - 1. GearGrid Corporation, 670 SW 15<sup>th</sup> Street, Forest Lake, MN 55025. Toll-free 888-643-6694. Phone 651-464-4468. Fax 651-464-4780. Web site [www.geargrid.com](http://www.geargrid.com). Email [sales@geargrid.com](mailto:sales@geargrid.com).
  - 2. Additional manufacturer's may be approved, however approval does not preclude the manufacturer from providing documentation supporting their product meets or exceeds all aspects of this specification section. Failure to provide proper documentation will result in the rejection of submitted product.

### 2.2 TURNOUT GEAR LOCKER FABRICATION

- A. Lockers must be fabricated and manufactured in the U.S.A. Products not manufactured in the U.S.A will be rejected at the time of submittals.
- B. Model: GEARGRID Wall Mounted Storage System.
- C. Locker Sizes: (Please reference project drawings for indicated sizes)
  - 1. Super Jumbo 24": Overall dimension- 74.5" high x 25.25" wide x 24" deep.
    - a) Clear Opening Width: 22.75"
- D. Construction: Units shall be welded at all applicable joints. Forming of metal shall be completed by standard cold-forming operations. Use of fasteners will only be required to allow for knock- down shipping, securing units to mounting surface and on applicable accessories.
- E. Vertical Dividers:
  - 1. Outer Frames: 1.25" O.D. x 16 gauge wall thickness ASTM A513 steel tubing.
  - 2. Inner Grid: .25" diameter ASTM 510 cold drawn steel wire resistance welded to a 3" square pattern.
  - 3. Inner Grid wires must be full length and width of inside vertical divider frame. Wires not running full length or width, thus creating exposed wire ends will not be acceptable.
  - 4. Inner Grid wires must run horizontally and vertically creating a square or rectangular grid pattern only. Grid wires not creating a square or rectangular grid pattern will not be acceptable.

5. Inner Grid wires shall intersect and cross all perpendicular wires, and shall be welded at all intersections.

F. Back Panel:

1. Required on each locker to protect the locker contents and wall substrate, as well as provide an additional panel for accessory attachment.
2. Grid: .25" diameter ASTM 510 cold drawn steel wire resistance welded to a 3" square pattern.
3. Back panel must engage and be secured to vertical dividers via horizontal wires which extend into mounting holes pre-drilled in vertical dividers. Back panels are sandwiched between vertical dividers, preventing them from being removed after assembly is complete.
4. Inner Grid wires must be full length and width of inside vertical divider frame. Wires not running full length or width, thus creating exposed wire ends will not be acceptable.
6. Inner Grid wires must run horizontally and vertically creating a square or rectangular grid pattern only. Grid wires not creating a square or rectangular grid pattern will not be acceptable.
5. Inner Grid wires shall intersect and cross all perpendicular wires, and shall be welded at all intersections.

- G. Shelves: (1) Upper, (1) Lower. .25" diameter ASTM 510 cold drawn steel wire resistance welded and cold formed. Upper shelf shall include an integrated 20 gauge steel bracket to accept a 2" x 16" name placard(not included), unless doors are selected as an option, in which case the name placard holder will be integrated into the door.

- H. Apparel Hooks: (3) per locker opening. .192" diameter ASTM 510 cold drawn steel wire resistance welded, cold formed and powder coated. Apparel hooks must securely engage and snap onto side or back grid, to prevent unintentional disengagement of hook.

## 2.3 ACCESSORIES –

A. Door :

1. Frame: 1.25" O.D. x 16 gauge wall thickness ASTM A513 steel tubing.
2. Inner Grid: .25" diameter ASTM 510 cold drawn steel wire resistance welded to a 3" square pattern.
3. Inner Grid wires must be full length and width of inside vertical divider frame. Wires not running full length or width, thus creating exposed wire ends will not be acceptable.

4. Inner Grid wires shall intersect and cross all perpendicular wires, and shall be welded at all intersections
5. Top Cover: .25" diameter ASTM 510 cold drawn steel wire resistance welded to a 3" square pattern. To securely enclose the top of the locker. Top cover must engage and be secured to vertical dividers via horizontal wires which extend into mounting holes pre-drilled in vertical dividers. Top Covers are sandwiched between vertical dividers, preventing them from being removed after assembly is complete.
6. Hinge: Single pin welded style with brass pivot bushing. Door and Vertical Divider hinge components must be welded and not mechanically fastened.
7. Placard Channel: 20 gauge steel to accept a 2" x 12" name placard(not included), securely welded to inner grid panel
8. Latch/Hasp: Self-latching with padlock hasp, constructed as follows; Vertical Divider side latch shall be minimum .125 in. sheet steel welded to Vertical Divider frame. Door side latch shall be constructed of .125 in. sheet steel and .1875 in. wire. Latch components manufactured from formed wire will not be acceptable. Lock by owner.

#### B. Hang Bar

1. Hang Bars must be manufactured to allow each locker user to install at their desired height. Hang Bars that span multiple locker openings are not acceptable.
2. Tube: 1.25"O.D. x 16 gauge 304 stainless steel tubing.
3. Brackets: Allow Hang Bars to be securely attached to each vertical divider, powder coated.

#### C. Heavy Hanger :

1. .25" diameter 304 stainless steel wire cold formed and resistance welded.
2. Black vinyl coating on hook end.

#### D. Gear Dryer Hanger :

1. .25" diameter 304 stainless steel wire cold formed and resistance welded. Includes formed loops to prop open sleeves on jackets to promote better circulation throughout the garment.
2. Black vinyl coating on hook end.

#### E. Glove Drying Hanger :

1. .25" diameter 304 stainless steel wire cold formed and resistance welded.
2. Black vinyl coating on hook end.

#### F. Helmet Holder (optional, not recommended when Door and Top Cover option or

Top Side Storage option is also selected):

1. .25" diameter ASTM 510 cold drawn steel wire resistance welded. Powder coated finish in specified color.

G. Secure Box :

1. 6" wide x 6" high x 12" deep 6061 Aluminum enclosure with hinged, lockable door at outer end. Design shall include an integrated mail slot. Powder coated finish in specified color.

H. Power Bar (optional on 20" and 24"):

1. 16 gauge steel chase integrated into the upper framework of the locker assembly allowing provision for the installation of a 120VAC duplex outlet at each locker location. Powder coated finish in specified color.

*a. No outlets or electrical connections included with Power Bars.*

I. Top Side Storage :

1. Shelf spanning across the top of the lockers for additional gear storage above lockers. .25" diameter ASTM 510 cold drawn steel wire resistance welded to a 3" square pattern. Powder coated finish in specified color.

## 2.4 FINISH

A. General: All system components excluding assembly and mounting hardware and stainless steel components are to receive the standard finish.

B. Standard Finish: Components to be cleaned using a phosphatized bath, clear water rinse and electro-statically coated with a durable and UV-stable TGIC powder coating process. Thickness of applied finish shall be 3 – 4 mm for added protection.

1. Anti-Corrosive Primer: (Optional)

C. Color: (Manufacturer must provide a minimum 7 standard color choices for selection)

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine area to receive lockers. Notify architect if area are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

### 3.2 INSTALLATION

- A. Install lockers in accordance with manufacturer's instructions.
- B. Use manufacturer's hardware for assembly.



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C. Anchor to mounting surface with proper hardware.

END OF SECTION

## SECTION 105113 - METAL LOCKERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Standard metal lockers.
  - 2. Locker benches.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- B. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Show locker trim and accessories.
  - 2. Include locker identification system and numbering sequence.
- C. Samples for Verification: For metal lockers and locker benches, in manufacturer's standard sizes.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single manufacturer.
- C. Regulatory Requirements: Where metal lockers and benches are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities," 2010 Edition.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures.
    - b. Faulty operation of latches and other door hardware.
  - 2. Damage from deliberate destruction and vandalism is excluded.
  - 3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
- B. Steel Tube: ASTM A 500, cold rolled.
- C. Particleboard: ANSI A208.1, Grade M-2.
- D. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
- E. Anchors: Material, type, and size required for secure anchorage to each substrate.
  - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts for corrosion resistance.

### 2.2 STANDARD METAL LOCKERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Lyon Workspace Products, LLC; Standard Lockers.
  - 2. Penco Products, Inc.; Guardian Lockers.
  - 3. Republic Storage Systems Company; Standard Lockers.
- B. Locker Arrangement: Single tier.
- C. Material: Metallic-coated steel sheet.
- D. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet as follows:
  - 1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch (0.61-mm) nominal thickness, with single bend at sides.
  - 2. Backs and Sides: 0.024-inch (0.61-mm) nominal thickness, with full-height, double-flanged connections.
  - 3. Shelves: 0.024-inch (0.61-mm) nominal thickness, with double bend at front and single bend at sides and back.
- E. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.

- F. Doors: One piece; fabricated from 0.048-inch (1.52-mm) nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
  - 1. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet; welded to inner face of doors.
  - 2. Door Style: Vented panel as follows:
    - a. Louvered Vents: No fewer than six louver openings at top and bottom for single-tier lockers.
- G. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
  - 1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
- H. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond face of door; pry and vandal resistant.
  - 1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and pre-locking.
    - a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
    - b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated with vinyl or nylon to prevent metal-to-metal contact, and incorporating a pre-locking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
- I. Equipment: Equip each metal locker with identification plate and the following unless otherwise indicated:
  - 1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
  - 2. Coat Rods: For each compartment of single-tier metal lockers.
- J. Accessories:
  - 1. Continuous Sloping Tops: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm) nominal-thickness steel sheet.
    - a. Closures: Vertical -end type.

- b. Sloping-top corner fillers, mitered.
  - 2. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
  - 3. Filler Panels: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm) nominal-thickness steel sheet.
- K. Finish: powder coat.
  - 1. Color(s): As indicated in the Interior Material and Color Schedule.

### 2.3 LOCKER BENCHES

- A. Provide bench units with overall assembly height of 17-1/2 inches (445 mm).
- B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
  - 1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick) except provide minimum 18-inch- (508-mm-) wide tops where accessible benches are indicated.
  - 2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
- C. Freestanding Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top, complete with fasteners.

### 2.4 FABRICATION

- A. Fabricate metal lockers square, rigid, and without warp and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
  - 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
  - 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
- C. Knocked-Down Construction: Fabricate metal lockers using nuts, bolts, screws, or rivets for nominal assembly at Project site.
- D. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- E. Coat Rods: Fabricated from 3/4-inch- (19-mm-) diameter steel, chrome finished.
- F. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.

- G. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
  - 1. Sloping-top corner fillers, mitered.
- H. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.
- I. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

## 2.5 STEEL SHEET FINISHES

- A. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.
- B. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard, baked-polymer, thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

## 2.6 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 1. Run grain of directional finishes with long dimension of each piece.
  - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
  2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
  3. Anchor back-to-back metal lockers to floor.
- B. Knocked-Down Metal Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
1. Attach hooks with at least two fasteners.
  2. Attach door locks on doors using security-type fasteners.
  3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
    - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
  4. Attach recess trim to recessed metal lockers with concealed clips.
  5. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
  6. Attach sloping-top units to metal lockers, with closures at exposed ends.
- D. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.
- E. Freestanding Locker Benches: Place benches in locations indicated on Drawings.

### 3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
- B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105113



## SECTION 107516 - GROUND-SET FLAGPOLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes ground-set flagpoles made from **aluminum**.
- B. Owner-Furnished Material: Flags.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.
- B. Shop Drawings: For flagpoles.
  - 1. Include plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
  - 2. Include section, and details of foundation system.
- C. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.
- D. Delegated-Design Submittal: For flagpoles.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design flagpole assemblies.
- B. Seismic Performance: Flagpole assemblies shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
- C. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.
  - 1. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location is **SEE STRUCTURAL DRAWINGS. MUST BE A HURRICANE RATED FLAGPOLE.**
  - 2. Base flagpole design on **polyester & nylon or cotton** flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

### 2.3 ALUMINUM FLAGPOLES

- A. Aluminum Flagpoles: **Cone**-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241/B 241M & ASTM B 221 Alloy 6063, with a minimum wall thickness of 3/16 inch (4.8 mm).
- B. Exposed Height: **25 feet (7.5 m) & 30 feet (9 m) (See drawings for quantities)**
- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
  - 1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
  - 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
- D. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch (1.52-mm) wall thickness with 3/16-inch (4.8-mm) steel bottom plate and support plate; 3/4-inch- (19-mm-) diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.
  - 1. Flashing Collar: Same material and finish as flagpole.
- E. Cast-Metal Shoe Base: Made from aluminum **with same finish and color as flagpoles** for anchor-bolt mounting; furnish with anchor bolts.

1. Furnish ground spike.
- F. Hinged Baseplate: Cast-metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless-steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.
1. Finish: Same as flagpole.
  2. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
  3. Furnish ground spike.
- G. Pivoting Tilt Base: Steel baseplate with channel or rectangular tube uprights, pivot bolt, and locking device for tilting flagpole. Furnish tilting flagpole with steel counterweight box and weights, or furnish with internal counterweight. Furnish base with anchor bolts.
1. Finish: Same as flagpole.
  2. Furnish ground spike.

## 2.4 FITTINGS

- A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
1. 0.063-inch (1.6-mm) spun aluminum, **with gold anodic finish**].
- B. External Halyard: Ball-bearing, non-fouling, revolving truck assembly of cast metal with continuous **5/16-inch- (8-mm-) diameter, braided polypropylene halyard** and 9-inch (228-mm) cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
1. Halyards and Cleats: **One** at each flagpole.
  2. Cleat Covers: Cast metal, finished to match flagpole, secured with cylinder locks.
  3. Halyard Covers: 2-inch (50-mm) channel, 60 inches (1500 mm) long, finished to match flagpole.
  4. Halyard Flag Snaps: **Stainless-steel** swivel snap hooks **with neoprene covers**. Furnish two per halyard.
- C. Cleat Cover Box with padlock

## 2.5 MISCELLANEOUS MATERIALS

- A. Non-shrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.
- B. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
- C. Sand: ASTM C 33/C 33M, fine aggregate.
- D. Elastomeric Joint Sealant: [**Multicomponent nonsag urethane**] [**Single-component nonsag urethane**] [**Single-component neutral-curing silicone**] joint sealant complying with requirements in Section 079200 "Joint Sealants."

- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

## 2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, **AA-M12C22A41**

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.
- B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
- D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.
- E. Sleeves: Locate and secure sleeves in forms by bracing to reinforcement and forms.
- F. Anchor Bolts: Locate and secure anchor bolts in forms with templates and by tying to reinforcement.
- G. Place concrete, as specified in **Section 033000 "Cast-in-Place Concrete."** Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.
- H. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

### 3.2 FLAGPOLE INSTALLATION

- A. General: Install flagpoles where indicated and according to [**Shop Drawings and**] manufacturer's written instructions.
- B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a **2-inch (50-mm)** layer of elastomeric joint sealant and cover with flashing collar.
- C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten

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retaining nuts and fill space under baseplate solidly with non-shrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

END OF SECTION 107516

***DIVISION 11***  
***EQUIPMENT***

## SECTION 115213 - PROJECTION SCREENS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Electrically operated, front-projection screens and controls.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal support framing for front-projection screens.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show layouts and types of front-projection screens. Include the following:

1. Drop lengths.
2. Anchorage details, including connection to supporting structure for suspended units.
3. Details of juncture of exposed surfaces with adjacent finishes.
4. Location of wiring connections for electrically operated units.
5. Wiring diagrams for electrically operated units.
6. Accessories.

#### 1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For front-projection screens to include in maintenance manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver or install front-projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## 1.5 COORDINATION

- A. Coordinate layout and installation of front-projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment, fire-suppression system, and partitions.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Projection Screens: Obtain front-projection screens from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.
- B. Basis of Design: Da-Lite Tensioned Advantage (with Closure Door), Wide (16:10) Format, Viewing Area: 100" x 160"**

### 2.2 ELECTRICALLY OPERATED, FRONT-PROJECTION SCREENS

- A. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Controls: Remote, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
  - 3. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
  - 4. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a 3/8-inch- (9.5-mm-) diameter metal rod with ends of rod protected by plastic caps.
    - a. Roller for motor in roller is supported by vibration- and noise-absorbing supports.
- B. Suspended, Electrically Operated Screens with Automatic Ceiling Closure, with Motor-in-Roller, and without Tab Tensioning: Units designed and fabricated for suspended mounting; with bottom of case composed of two panels, fully enclosing screen, motor, and wiring; one panel hinged and designed to open and close automatically when screen is lowered and fully raised, the other removable or openable for access to interior of case.



1. Provide metal or metal-lined wiring compartment.
2. Screen Case: Made from metal.
3. Provide screen case constructed to be installed with underside flush with ceiling.

### 2.3 FRONT-PROJECTION SCREEN MATERIAL

- A. Matte-White Viewing Surface: Peak gain of not less than 0.9, and gain of not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.
- B. Material: Vinyl-coated, glass-fiber fabric.
- C. Mildew-Resistance Rating: Zero or 1 when tested according to ASTM G 21.
- D. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
- E. Seamless Construction: Provide screens, in sizes indicated, without seams.
- F. Edge Treatment: Black masking borders.
- G. Provide extra drop length of dimensions and at locations indicated.
  1. Color: Black.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
  1. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
    - a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
  2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
- C. Verify manufacturer's variable position mounting brackets per size and weight of specified

screen housing and provide 3/8" threaded rods (two per bracket) and suspended from light gauge metal trusses.

3.2 FRONT-PROJECTION SCREEN SCHEDULE

- A. Electrically Operated, Front-Projection Screen Type: Suspended, with automatic ceiling closure.
  - 1. Motor Configuration: Motor in roller.
  - 2. Screen Surface: Matte white.
  - 3. Size of Viewing Surface: 100" x 160"
  - 4. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor.

END OF SECTION 115213

***DIVISION 12***  
***FURNISHINGS***

## SECTION 122413 – ROLLER WINDOW SHADES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Manually operated roller shades with double and single rollers
- 2. Motor-operated roller shades with double rollers.

- B. Related Requirements:

- 1. Division 06 Section "Rough Carpentry" or "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
- 2. Division 07 Section "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.
- 3. Division 08 Section "Aluminum Windows."
- 4. Division 08 Section "Glazed Aluminum Curtainwalls."
- 5. Division 09 Section "Gypsum Wallboard Systems" coordination with gypsum wallboard systems for installation of shade pockets, closures and related accessories.
- 6. Division 09 Section "Acoustical Ceilings" coordination with acoustical ceiling systems for installation shade pockets, closures and related accessories.
- 7. Division 26 Section for power, voltage and circuiting requirements.

#### 1.3 REFERENCES

- A. ASTM International (ASTM):

- 1. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

- B. Cradle to Cradle Products Innovation Institute (C2C):

- 1. C2C (DIR) - C2C Certified Products Registry.

- C. National Fire Protection Association (NFPA):

- 1. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- 2. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

- D. Underwriters Laboratories (UL):

- 1. UL (GGG) - GREENGUARD Gold Certified Products; Current Edition.

2. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

E. Window Covering Manufacturers Association (WCMA):

1. WCMA A100.1 - Safety of Window Covering Products; 2018.

#### 1.4 ACTION SUBMITTALS

A. Submit items in accordance with Division 01 Section "Submittal Procedures."

B. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, operating instructions, installation instructions and accessories specified and/or required by manufacturer.

- C. Shop Drawings: Plans, elevations and sections showing fabrication and installation details for roller shades, including shade band materials, their orientation to rollers, and their seam and batten locations.
- D. Samples for Verification: For each type of roller shade.
  - 1. Shadeband Material: Submit two (2) Samples not less than 10 inches square. Mark inside face of material if applicable.

2



## 2.1 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Methods for maintaining roller shades, cleaning instructions and instructions for operating hardware and controls.

## 2.2 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

## 2.3 QUALITY ASSURANCE

- A. Installer Qualifications: Verify Installer is qualified and approved by Manufacturer/Supplier, with a minimum of ten years of continuous, uninterrupted experience in successfully installing work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who agrees to employ only skilled tradesmen with a minimum of five years of experience.

3

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

3.2 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

3.3 WARRANTY

- A. Rollershade Hardware, (Chain and Shadecloth): Non-depreciating twenty-five year limited warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc.: **(SEE FURNITURE & EQUIPMENT PLANS FOR LOCATIONS & TYPES)**
  - 1. Manual Operated: **Mecho/7 System**
  - 2. Motor-Operated: **ElectroShade® with WhisperShade.**
- B. or comparable product by one of the following:

1. Draper Inc.
2. Lutron Electronics Co., Inc.
3. Hunter Douglas Contract

## 2.2 MANUALLY & MOTOR OPERATED SHADES WITH DOUBLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
1. Bead Chains: Stainless steel rated to 90 lbs. minimum breaking strength.
    - a. Loop Length: Full length of roller shade.
    - b. Limit Stops: Provide upper and lower ball stops.
    - c. Chain-Retainer Type: Clip, jamb mount.
  2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller- shade weight and lifting heavy roller shades.
    - a. Provide for shadebands that weigh more than 10 lbs. or for shades as recommended by manufacturer, whichever criteria are more stringent.
- B. Spring Operating Mechanisms: Roller contains spring sized to accommodate shade size indicated. Provide with positive locking mechanism that can stop shade movement at each half-turn of roller and with manufacturer's standard pull.
1. Pole: Manufacturer's standard type in length required to make operation convenient from floor level and with hook for engaging pull.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive- end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Double-Roller Mounting Configuration:
    - a. Offset, outside roller over and inside roller under.
  2. Inside Roller:
    - a. Drive-End Location: Right side of inside face of shade.
    - b. Direction of Shadeband Roll: Regular, from back of roller.
  3. Outside Roller:
    - a. Drive-End Location: Right side of inside face of shade.
    - b. Direction of Shadeband Roll: Regular, from back of roller.
  4. Shadeband-to-Roller Attachment: Removable spline fitting integral channel in tube.



- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.
  - 1. Shade hardware to support 150 percent of the full weight of each shade.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive- end assembly.
- F. Inside Shadebands: (Selected from Manufacturer's Standard Colors)
  - 1. Shadeband Material: Light-filtering fabric
  - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type: Enclosed in sealed pocket of shadeband material
- G. Outside Shadebands: (Selected from Manufacturer's Standard Colors)
  - 1. Shadeband Material: Light-blocking fabric
  - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type:
      - 1) Exposed with endcaps and integral light seal where bottom (sill) channels are indicated.
- H. Line Voltage EDU (120 VAC):
  - 1. Basis of Design: MechoShade Systems LLC; WhisperShade IQ2 System. Tubular, asynchronous, integral AC motor and reversible capacitor. 120 VAC, single phase, 60 Hz; temperature Class B, thermally-protected, totally enclosed, maintenance-free. Powered by line voltage power supply connection equipped with locking disconnect plug assembly furnished with EDU.
  - 2. Audible Noise: 46 dBA measured 3 ft (914 mm) from motor unit, depending on motor torque.
  - 3. Nominal Speed: 34 RPM. Not to vary due to load/lift capacity.
  - 4. Isolated, low voltage power supply for powering external accessories connected to either the dry contact or network port.
    - a. Products requiring accessories to be powered by a plug-in or externally-supplied power supply are not acceptable.
- I. Installation Accessories:
  - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Shape: L-shaped
    - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open.
    - c. Color: Clear Anodized

2. Endcap Covers: To cover exposed endcaps.
3. Installation Accessories Color and Finish: Match front fascia.

### 2.3 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Stainless steel rated to 90 lbs. minimum breaking strength.
  - a. Loop Length: Full length of roller shade
  - b. Limit Stops: Provide upper and lower ball stops.
  - c. Chain-Retainer Type: Clip, jamb mount

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller- shade weight and lifting heavy roller shades.
  - a. Provide for shadebands that weigh more than 10 lbs. or for shades as recommended by manufacturer, whichever criteria are more stringent.
- B. Spring Operating Mechanisms: Roller contains spring sized to accommodate shade size indicated. Provide with positive locking mechanism that can stop shade movement at each half-turn of roller and with manufacturer's standard pull.
  1. Pole: Manufacturer's standard type in length required to make operation convenient from floor level and with hook for engaging pull.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive- end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
  1. Roller Drive-End Location: Right side of inside face of shade.
  2. Direction of Shadeband Roll: Regular, from back of roller.
  3. Shadeband-to-Roller Attachment: Removable spline fitting integral channel in tube.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
  1. Shade hardware to support 150 percent of the full weight of each shade.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive- end assembly.
- F. Shadebands: (Selected from Manufacturer's Standard Colors)
  1. Shadeband Material: Light-filtering fabric
  2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type:
      - 1) Enclosed in sealed pocket of shadeband material.
- G. Installation Accessories:
  1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Shape: L-shaped
    - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open.
    - c. Color: Clear Anodized

2. Endcap Covers: To cover exposed endcaps.
3. Installation Accessories Color and Finish: Match front fascia.

#### 2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and faderesistant.
  1. Visually Transparent Single-Fabric Shadecloth: ThermoVeil Group, single thickness non-raveling 0.030-inch thick vinyl fabric, woven from 0.018-inch diameter extruded vinyl yarn.
    - a. Dense Vertical Weave: "1000 Series" - approximate 2-3% openness factor
- C. Light-Blocking Fabric: Opaque fabric; stain and faderesistant.
  1. Vinyl Room Darkening Single-Fabric Shadecloth: "0700 Series" – classic blackout, 0.012-inch thick blackout material, 14 oz. per square yard, 62 threads per square inch.

#### 2.5 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
  1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
  1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
  2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- 4 Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

4.1 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

4.2 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

4.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated rollershades.

END OF SECTION 122413

***DIVISION 22***

***PLUMBING***

## SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

#### 2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

- b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
  - c. Insulated Piping: One-piece, stamped-steel type.
  - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
  - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
  - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
  - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
  - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.

### 3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518



## SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B16.18 for solder-joint connections.
4. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Handlever: For quarter-turn valves.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

## 2.2 BRASS BALL VALVES

### A. One-Piece, Brass Ball Valves:

#### 1. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 400 psig.
- c. Body Design: One piece.
- d. Body Material: Forged brass or bronze.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Brass or stainless steel.
- h. Ball: Chrome-plated brass or stainless steel.
- i. Port: Reduced.

### B. Two-Piece, Brass Ball Valves with Full Port and Brass Trim:

#### 1. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Forged brass.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Brass.
- h. Ball: Chrome-plated brass.
- i. Port: Full.

### C. Two-Piece, Brass Ball Valves with Regular Port and Brass Trim:

#### 1. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Forged brass.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Brass.
- h. Ball: Chrome-plated brass.
- i. Port: Regular.

## 2.3 BRONZE BALL VALVES

### A. One-Piece, Bronze Ball Valves:

1. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 400 psig.
  - c. Body Design: One piece.
  - d. Body Material: Bronze.
  - e. Ends: Threaded.
  - f. Seats: PTFE.
  - g. Stem: Bronze.
  - h. Ball: Chrome-plated brass.
  - i. Port: Reduced.

### B. Two-Piece, Bronze Ball Valves with Full Port, and Bronze or Brass Trim:

1. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Bronze.
  - e. Ends: Threaded and soldered.
  - f. Seats: PTFE.
  - g. Stem: Bronze or brass.
  - h. Ball: Chrome-plated brass.
  - i. Port: Full.

### C. Two-Piece, Bronze Ball Valves with Regular Port and Bronze or Brass Trim:

1. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Bronze.
  - e. Ends: Threaded.
  - f. Seats: PTFE.
  - g. Stem: Bronze or brass.
  - h. Ball: Chrome-plated brass.
  - i. Port: Regular.

### PART 3 - EXECUTION

#### 3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

#### 3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
  - 2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

#### 3.3 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
  - 2. One piece, brass ball valve.
  - 3. One piece, bronze ball valve with bronze trim.
  - 4. Two-piece, brass ball valves with full port and brass trim.
  - 5. Two-piece, bronze ball valves with full port and bronze or brass trim.

#### 3.4 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
  - 2. One piece, brass ball valve.
  - 3. One piece, bronze ball valve with bronze trim.
  - 4. Two-piece, brass ball valves with full port and brass trim.
  - 5. Two-piece, bronze ball valves with full port and bronze or brass trim.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. One piece, brass ball valve.
3. One piece, bronze ball valve with bronze trim.
4. Two-piece, brass ball valves with full port and brass trim.
5. Two-piece, bronze ball valves with full port and bronze or brass trim.

END OF SECTION 220523.12

## SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product indicated.

##### B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

#### 1.3 INFORMATIONAL SUBMITTALS

##### A. Welding certificates.

#### 1.4 QUALITY ASSURANCE

##### A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

##### B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

### PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

##### A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel with galvanized coating or stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

## 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## 2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.



- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 Specifications.

- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  5. C-Clamps (MSS Type 23): For structural shapes.
  6. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  7. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  8. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

- P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

## SECTION 220719 - PLUMBING PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Supplies and drains for handicap-accessible lavatories and sinks.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Block Insulation: ASTM C 552, Type I.
  - 2. Special-Shaped Insulation: ASTM C 552, Type III.
  - 3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  - 4. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
  - 5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 SEALANTS

- A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.4 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.5 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
  2. Thickness: 11.5 mils.
  3. Adhesion: 90 ounces force/inch in width.
  4. Elongation: 2 percent.
  5. Tensile Strength: 40 lbf/inch in width.
  6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.



### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Cleanouts.

### 3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.5 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.6 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
  - 4. Drainage piping located in plenum.

### 3.7 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. 2-Inch and Smaller: Insulation shall be the following:
    - a. Cellular Glass: 1-1/2 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
  - 1. 3/4-Inch and Smaller: Insulation shall be the following:
    - a. Cellular Glass: 1-1/2 inches thick.

END OF SECTION 220719

## SECTION 221116 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

#### 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
  - 1. MSS SP-123.
  - 2. Cast-copper-alloy, hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal seating surfaces.
  - 4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint Fittings:

1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:

1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

## 2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

## 2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53/A 53M, Standard Weight.
2. Include ends matching joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Malleable-Iron Unions:

1. ASME B16.39, Class 150.
2. Hexagonal-stock body.

3. Ball-and-socket, metal-to-metal, bronze seating surface.
4. Threaded ends.

E. Flanges: ASME B16.1, Class 125, cast iron.

## 2.5 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

## 2.6 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.

B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.

C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

## 2.7 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.8 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
  - 1. Description:
    - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
    - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- D. Plastic-to-Metal Transition Unions:
  - 1. Description:
    - a. CPVC or PVC four-part union.
    - b. Brass or stainless-steel threaded end.
    - c. Solvent-cement-joint or threaded plastic end.
    - d. Rubber O-ring.
    - e. Union nut.

## 2.9 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Standard: ASSE 1079.



- C. Dielectric Flanges:
  - 1. Standard: ASSE 1079.
- D. Dielectric Nipples:
  - 1. Standard: IAPMO PS 66.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

#### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install shutoff valve immediately upstream of each dielectric fitting.
- C. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- D. Install domestic water piping level and plumb.
- E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.

- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- N. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

I. Joints for PEX Piping: Join according to ASTM F 1807.

J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

### 3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

### 3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

### 3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
  - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
  - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
  - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
  - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
  - 7. NPS 6: 12 feet with 3/4-inch rod.
  - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- G. Install supports for vertical steel piping every 15 feet.
- H. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 5. NPS 6: 48 inches with 3/4-inch rod.
  - 6. NPS 8: 48 inches with 7/8-inch rod.
- I. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- J. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
  - 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 4. NPS 6: 48 inches with 3/4-inch rod.
  - 5. NPS 8: 48 inches with 7/8-inch rod.
- K. Install supports for vertical PVC piping every 48 inches.
- L. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

### 3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
  - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### 3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
    - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  - 2. Piping Tests:
    - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

### 3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
  - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
  - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

- a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Repeat procedures if biological examination shows contamination.
  - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

### 3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water piping, shall be the following:
  1. Hard copper tube, ASTM B 88, Type L.
- E. Aboveground domestic water piping, shall be the following:
  1. Hard copper tube, ASTM B 88, Type Lcopper, solder-joint fittings; and brazed joints.

END OF SECTION 221116

## SECTION 221316 - SANITARY WASTE AND VENT PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Pipe, tube, and fittings.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

#### 2.2 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.



- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
  - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Solvent Cement: ASTM D 2564.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

### 2.3 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
  - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  - 3. Unshielded, Nonpressure Transition Couplings:
    - a. Standard: ASTM C 1173.
    - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - c. Sleeve Materials:
      - 1) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      - 2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  - 4. Shielded, Nonpressure Transition Couplings:
    - a. Standard: ASTM C 1460.
    - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

### PART 3 - EXECUTION

#### 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

#### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping.
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1/4 inch downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Sanitary Drainage Piping: 1/8 inch per foot downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install aboveground PVC piping according to ASTM D 2665.
- O. Install underground PVC piping according to ASTM D 2321.
- P. Install engineered soil and waste drainage and vent piping systems as follows:
  - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
  - 2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- Q. Plumbing Specialties:
  - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping.
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.3 JOINT CONSTRUCTION

- A. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

### 3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- B. Shutoff Valves:
  - 1. Install shutoff valve on each sewage pump discharge.
  - 2. Install full-port ball valve for piping NPS 2 and smaller.

3. Install full-port ball valve for piping NPS 2-1/2 and larger.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices.
- B. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
  2. NPS 3: 48 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- C. Install supports for vertical PVC piping every 48 inches.
- D. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
  1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
  2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  3. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
  1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### 3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.

### 3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
  - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
  - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - 6. Prepare reports for tests and required corrective action.

### 3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

### 3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
  - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, vent piping NPS 4 and smaller shall be the following:
  - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
  - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316

## SECTION 22 13 19 - TILE FLOOR AND SHOWER DRAINS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Tile Floor and Shower Drains.

#### 1.2 RELATED SECTIONS

- A. Section 09 30 00: Tiling.
- B. Section 09 30 01: Tile Shower Components and Waterproofing Membrane. Shower trays, curbs, ramps, bench, niche, sealing compound, waterproofing membrane, drainage panels, drainage membrane compatible with floor drains.

#### 1.3 REFERENCES

- A. IAPMO IGC 195: Interim Guide Criteria for Floor Drain with Integrated Bonding Flange.
- B. CSA B79-08: Floor, Area, and Shower Drains, and Cleanouts for Residential Construction.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 0.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Catalog information, component sizes, rough-in requirements, service sizes, and finishes.
  - 3. Storage and handling requirements and recommendations.
  - 4. Installation Instructions.
- C. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and finish.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum five years' experience.
- B. Source Limitations for Materials and Accessories: Obtain product of a uniform quality for each application condition from a single manufacturer.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Architect.
  - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.

3. Refinish mock-up area as required to produce acceptable work.
- D. Preinstallation Conference: Conduct conference at the Project site.
  1. Convene one week prior to commencing work of this section.
  2. Require attendance of installation material manufacturer, plumber, waterproofing installer, tile installer and installers of related work. Review installation procedures and coordination required with related work.
  3. Meeting agenda includes but is not limited to:
    - a. Drain location.
    - b. Prefabricated substrate requirements.
    - c. Drainage membrane requirements.
    - d. Tile and installation material compatibility.
    - e. Edge protection, transition and pre-fabricated movement joint profiles.
    - f. Waterproofing techniques.
    - g. Crack isolation techniques.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weathertight location.

#### 1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### 1.8 COORDINATION

- A. Coordinate Work with other operations and installation of floor finish materials to avoid damage to installed materials.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Schluter Systems, L.P., 194 Pleasant Ridge Road, Plattsburgh, NY 12901-5841. ASD. Tel: (800) 472-4588. Fax (800) 477-9783. E-mail: [specassist@schluter.com](mailto:specassist@schluter.com). Web: [www.schluter.com](http://www.schluter.com).
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

#### 2.2 FLOOR AND SHOWER DRAINS

- A. Schluter-KERDI-LINE DRAIN: Brushed Stainless Steel Linear floor drain. Formed stainless steel channel body and grate assembly. Seamlessly adjustable to tile or stone covering thickness from 1/8 inch to 1 (3 to 25 mm).
  1. Channel Body Features: 2-1/4 inch (57 mm) wide trough, 2 inch (50 mm) no-hub outlet, and a 7/8 inch (22 mm) wide bonding flange laminated with a



- collar made of the Schluter-KERDI waterproofing membrane.
2. Drain Type: As referenced in methods B422 and B422 STONE in the Tile Council of North America Handbook for Ceramic, Glass, and Stone Tile Installation.
  3. Channel Body Material: Stainless Steel 304 (1.4301 equals V2A).
  4. Channel Body and Grate Nominal Length: 56 inch (140 cm).
  5. Grate Frame Height: Height as required to coordinate with tile selection and setting system selected.
  6. Grate Design: Perforated. Grate, frame, and insert form the visible surface.
    - a. Grate: Brushed stainless steel 304 (1.4301 equals V2A) with square perforations and locking mechanism.
    - b. Grate Frame: 3/8 inch (10 mm) wide brushed stainless steel.
    - c. Grate insert: 2-1/8 inch (54 mm) wide.
  7. Drain Outlet: Center.
  8. Drain Grate Connector Plate: Brushed stainless steel 304 (1.4301 equals V2A).
- B. Schluter-KERDI-FIX: Single-component, elastomeric, waterproof sealing, and bonding compound with a silane-modified polymer base. Compound is free of solvents and odorless.
1. Color: G: Grey.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify drain location and compatibility with drain system specified.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces by removing all debris, sharp edges and protrusions that could damage the waterproof integrity of the system.
- C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate Work with installation of prefabricated shower trays, load-bearing bonded waterproof membrane meeting ANSI A118.10, drainage membrane and other components specified in Section 09 30 00 and with setting materials for floor finish materials specified in Section 09 30 50.

### 3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

## SECTION 221519 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Lubricated, reciprocating air compressors.
2. Inlet-air filters.
3. Refrigerant compressed-air dryers.

#### 1.2 DEFINITIONS

- A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm
- B. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### 1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

#### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event.**"

2.3 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

- A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
  - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
  - 2. Motor Controllers: Full-voltage, combination magnetic type with under voltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
  - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
  - 4. Motor Overload Protection: Overload relay in each phase.
  - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
  - 6. Automatic control switches to **alternate lead-lag compressors for duplex** air compressors.
  - 7. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
  - 8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.

- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  - 1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
  - 2. Interior Finish: Corrosion-resistant coating.
  - 3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.
- D. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

#### 2.4 LUBRICATED, RECIPROCATING AIR COMPRESSORS

- A. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
  - 1. Submerged gear-type oil pump.
  - 2. Oil filter.
  - 3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
  - 4. Belt guard totally enclosing pulleys and belts.
- B. Capacities and Characteristics:
  - 1. Air Compressor(s): **Two** stage.
    - a. Intercooler between stages of two-stage units.
  - 2. Standard-Air Capacity of Each Air Compressor: 52 scfm free air.
  - 3. Actual-Air Capacity of Each Air Compressor: 52 scfm delivered.
  - 4. Discharge-Air Pressure: **175 psig**
  - 5. Mounting: **Freestanding**
  - 6. Motor (Each Air Compressor):
    - a. Horsepower: 15 hp.
    - b. Speed: **1750** rpm.
  - 7. Electrical Characteristics:
    - a. Volts: **208**.
    - b. Phase(s): **Three**.
    - c. Hertz: **60**.
  - 8. Receiver: ASME construction steel tank.
    - a. Arrangement: **Horizontal**.
    - b. Pressure Rating: **125 psig** minimum.
    - c. Pressure Regulator Setting: 150 **psig**.
    - d. Drain: **Manual** valve.

2.5 OIL-FREE, RECIPROCATING AIR COMPRESSORS

2.6 INLET-AIR FILTERS

- A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
  2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.
- B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
  2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.7 AIR-COOLED, COMPRESSED-AIR AFTERCOOLERS

2.8 REFRIGERANT COMPRESSED-AIR DRYERS

- A. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100-psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.
- B. Capacities and Characteristics:
1. Standard-Air Capacity of Each Compressed-Air Dryer: 34 **scfm** free air.
  2. Pressure: 175 **psig**.
  3. Motor Horsepower: ½ hp.
  4. Electrical Characteristics:
    - a. Volts: 115.
    - b. Phase(s): **Single**.
    - c. Hertz: 60.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Equipment Mounting:

1. Install air compressors **and air dryers** on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundations.
  2. Install **desiccant compressed-air dryers** mounted on wall.
- B. Install compressed-air equipment anchored to substrate.
- C. Arrange equipment so controls and devices are accessible for servicing.
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Install the following devices on compressed-air equipment:
1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
  2. Pressure Regulators: Install downstream from air compressor.
  3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers.

### 3.2 CONNECTIONS

- A. Where installing piping adjacent to machine, allow space for service and maintenance.

### 3.3 IDENTIFICATION

- A. Identify general-service air compressors and components.

### 3.4 STARTUP SERVICE

- A. **Perform** startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
  2. Check for lubricating oil in lubricated-type equipment.
  3. Check belt drives for proper tension.
  4. Verify that air-compressor inlet filters and piping are clear.
  5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
  6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
  7. Check for proper seismic restraints.
  8. Drain receiver tanks.
  9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  10. Test and adjust controls and safeties.

### 3.5 DEMONSTRATION

- A. **Train** personnel to adjust, operate, and maintain air compressors **and air dryer**.

END OF SECTION 221519

## SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Residential, electric, storage, domestic-water heaters.
2. Domestic-water heater accessories.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of residential, electric, domestic-water heater, from manufacturer.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Warranty: Sample of special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.



- C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
  - 2. Warranty Periods: From date of Substantial Completion.
    - a. Residential, Electric, Storage, Domestic-Water Heaters:
      - 1) Storage Tank: Five years.
      - 2) Controls and Other Components: Two years.

## PART 2 - PRODUCTS

### 2.1 RESIDENTIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Residential, Electric, Storage, Domestic-Water Heaters:
  - 1. Standard: UL 174.
  - 2. Storage-Tank Construction: Steel.
    - a. Tappings: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: 150 psig.
    - c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.
  - 3. Factory-Installed Storage-Tank Appurtenances:
    - a. Anode Rod: Replaceable magnesium.
    - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    - c. Drain Valve: ASSE 1005.
    - d. Insulation: Comply with ASHRAE 90.2.
    - e. Jacket: Steel, cylindrical, with enameled finish.
    - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
    - g. Heating Elements: Two; electric, screw-in immersion type; wired for non-simultaneous operation unless otherwise indicated. Limited to 12 kw total.

- h. Temperature Control: Adjustable thermostat.
- i. Safety Control: High-temperature-limit cutoff device or system.
- j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

## 2.2 DOMESTIC-WATER HEATER ACCESSORIES

### A. Domestic-Water Compression Tanks:

- 1. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
- 2. Construction:
  - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
  - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
  - c. Air-Charging Valve: Factory installed.
- 3. Capacity and Characteristics:
  - a. Working-Pressure Rating: 100 psig.
  - b. Capacity Acceptable: 2 gal. minimum.
  - c. Air Precharge Pressure: System pressure.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

E. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

## 2.3 SOURCE QUALITY CONTROL

- A. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
  - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- B. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- C. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- D. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- E. Fill electric, domestic-water heaters with water.
- F. Charge domestic-water compression tanks with air.

### 3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

END OF SECTION 223300

## SECTION 224100 - RESIDENTIAL PLUMBING FIXTURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Lavatories.
2. Kitchen sinks.
3. Water closets.
4. Toilet seats.
5. Supply fittings.
6. Waste fittings.
7. Showers

#### ACTION SUBMITTALS

- B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- C. LEED Submittals:

1. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.
- B. Sample Warranty: For special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.

#### PART 2 - PRODUCTS

#### 2.1 LAVATORIES

- A. Lavatories: Rectangular, wall hung vitreous china.

- 1. Vitreous-China Lavatories:
- 2. Fixture:
  - a. Standard: ASME A112.19.2/CSA B45.1 vitreous china.
  - b. Type: Wall hung
  - c. Faucet-Hole Punching: 4-inch center.
  - d. Color: White.

- B. Lavatories: Rectangular, undermount vitreous china.

- 1. Vitreous-China Lavatories:
- 2. Fixture:
  - a. Standard: ASME A112.19.2/CSA B45.1 vitreous china.
  - b. Type: Undermount with front overflow
  - c. Faucet-Hole Punching: 4-inch center.
  - d. Color: White.

#### 2.2 LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

- B. Lavatory Faucets: Single-control mixing valve sensor operated.

- 1. General-Duty, Solid-Brass Faucets:
- 2. Standard: ASME A112.18.1/CSA B125.1.
- 3. Body Material: General-duty, solid brass.
- 4. Finish: Polished chrome plate.
- 5. Maximum Flow Rate: 0.25 gpm.
- 6. Centers: 4 inches.
- 7. Mounting: Deck, exposed.
- 8. Valve Handle(s): Lever.
- 9. Inlet(s): NPS 3/8 tubing, plain end.
- 10. Spout: Rigid.

11. Spout Outlet: Aerator.
12. Drain: Pop up.

### 2.3 KITCHEN SINKS

#### A. Kitchen Sinks: Single bowl, counter mounted, stainless steel.

1. Stainless-Steel 18 gauge
2. Fixture:
  - a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.
  - b. Overall Dimensions: 22 inch by 20 inch by 6 inches deep.
  - c. Metal Thickness: 0.038 inch.
  - d. Bowl:
    - 1) Dimensions: 16 inches by 16 inches.
    - 2) Drain: 3-1/2-inch grid.
      - a) Location: Centered in bowl.
3. Faucet: complies with "Sink Faucets" Article.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multi-bowl sinks.
  - a. Disposer: Not required.
  - b. Dishwasher Air-Gap Fitting:
  - c. Hot-Water Dispenser: Not required.

### 2.4 SINK FAUCETS

#### A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

#### B. Sink Faucets: Solid brass,.

1. General-Duty, Solid-Brass Faucets:
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
4. Finish: Polished chrome plate.
5. Maximum Flow Rate: 1.0 gpm unless otherwise indicated.
6. Mixing Valve: Single-lever handle.
7. Centers: Center.
8. Mounting: Deck.
9. Handle(s): Lever.
10. Spout Type: Swing, Gooseneck, sprayer, solid brass.
11. Spout Outlet: Aerator.
12. Drain: Grid.

## 2.5 WATER CLOSETS

- A. Water Closets: Floor mounted, floor outlet, close coupled (gravity tank), vitreous china.
  - 1. Bowl:
    - a. Standards: ASME A112.19.2/CSA B45.1, ASME A112.19.5, and ASSE 1037.
    - b. Bowl Type: Siphon jet.
    - c. Height: Standard and Handicapped/elderly.
    - d. Rim Contour: Elongated.
    - e. Water Consumption: Water saving.
    - f. Color: White.
  - 2. Toilet Seat: white solid plastic, open front, elongated, self-rimming check hinge.
  - 3. Supply Fittings:
    - a. Standard: ASME A112.18.1/CSA B125.1.
    - b. Supply Piping: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
    - c. Stop: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.
      - 1) Operation: Trip lever handle.
    - d. Riser:
      - 1) Size: NPS 3/8.
      - 2) Material: Chrome-plated, soft-copper flexible tube riser.

## 2.6 TOILET SEATS

- A. Toilet Seats:
  - 1. Standard: IAPMO/ANSI Z124.5.
  - 2. Material: Plastic.
  - 3. Type: Commercial (Standard).
  - 4. Shape: Elongated rim (Open front).
  - 5. Configuration: Open front without cover.
  - 6. Size: Elongated.
  - 7. Hinge Type: Check.
  - 8. Hinge Material: Noncorroding metal.
  - 9. Seat Cover: Not required.
  - 10. Color: White.

## 2.7 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.



- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Lavatory and Kitchen Sink Supply Fittings:
  - 1. Supply Piping: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
  - 2. Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.
    - a. Operation: Wheel handle.
  - 3. Risers:
    - a. Size: NPS 3/8 for lavatories.
    - b. Size: NPS 1/2 for kitchen sinks.
    - c. Material: Chrome-plated, soft-copper flexible tube riser.

## 2.8 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset tailpiece for accessible lavatories.
- C. Drain: Pop-up type with NPS 1-1/4 straight tailpiece as part of faucet for standard lavatories.
- D. Drain: Grid type with NPS 1-1/2 offset tailpiece for accessible kitchen sinks.
- E. Trap:
  - 1. Size: NPS 1-1/2 by NPS 1-1/4 for lavatories.
  - 2. Size: NPS 1-1/2 for kitchen sinks.
  - 3. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated-brass or -steel wall flange.

## 2.9 SHOWERS

- A. Showers: Accessible with grab bar, base and faucet.
  - 1. Standard: ANSI Z124.1.2 and ICC/ANSI A117.1 for roll-in shower compartments.
  - 2. Nominal Size: 60 by 30 inches.
  - 3. Surround: Multiple piece.
  - 4. Bathing Surface: Slip resistant according to ASTM F 462.
  - 5. Drain Location: Left side or Right side.

## 2.10 SHOWER FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components – Health Effects," for faucet materials that will be in contact with potable water.

- B. Shower Faucets: Single handle, pressure balance, mixing valve.
  - 1. Single Handle, Pressure-Balance Faucets.
  - 2. Fixture:
    - a. Standard: ASME A112.18.1/CSA B125.1 and ASSE 1016.
    - b. General: Include hot- and cold-water indicators; check stops. Coordinate faucet inlets with supplies.
    - c. Body Material: Solid Brass.
    - d. Finish: Polished chrome plate.
    - e. Maximum Flow Rate: 2.5 gpm.
    - f. Mounting: Exposed.
    - g. Backflow-Prevention Device for Hand-Held Shower: Not required.
    - h. Operation: Compression, manual.
    - i. Antiscald Device: Integral with mixing valve.
    - j. Check Stops: check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
    - k. 48 inch slide bar.
  - 3. Supply Connections: NPA 1/2 .
  - 4. Shower Head:
    - a. Type: Integral with mounting flange.
    - b. Shower Head Material: Metallic with chrome-plated finish.
    - c. Spray Pattern: Adjustable.
    - d. Integral Volume Control: Not required.
    - e. Shower-Arm, Flow-Control Fitting: Not required.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install floor-mounted water closets on closet flange attachments to drainage piping.
- C. Install counter-mounting fixtures in and attached to casework.

- D. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
  - 1. Exception: Use ball valves if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping".
- E. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- F. Install toilet seats on water closets.
- G. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- H. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
- I. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."
- J. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- K. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

### 3.4 ADJUSTING

- A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

3.5 CLEANING AND PROTECTION

- A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed plumbing fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224100

## SECTION 224213.16 - COMMERCIAL URINALS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Urinals.
2. Flushometer valves.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### 1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 WALL-HUNG URINALS

A. Urinals: Wall hung, back outlet, siphon jet, accessible.

1. Fixture:
  - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - b. Material: Vitreous china.
  - c. Type: Siphon jet with extended shields.
  - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
  - e. Water Consumption: Water saving.
  - f. Spud Size and Location: NPS 3/4; top.
  - g. Outlet Size and Location: NPS 2; back.
  - h. Color: White.
2. Flushometer Valve.
3. Waste Fitting:

- a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
  - b. Size: NPS 2.
4. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

## 2.2 URINAL FLUSHOMETER VALVES

### A. Lever-Handle, Diaphragm Flushometer Valves:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Panel Finish: Chrome plated or stainless steel.
7. Style: Exposed.
8. Consumption: .125 gal. per flush.
9. Minimum Inlet: NPS 3/4.
10. Minimum Outlet: NPS 3/4.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Urinal Installation:
  1. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
- B. Support Installation:
  1. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
- C. Flushometer-Valve Installation:
  1. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- D. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.

### 3.3 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

### 3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

### 3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.16

## SECTION 224216.16 - COMMERCIAL SINKS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Mop sinks.
  - 2. Supply fittings.
  - 3. Waste fittings.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

### PART 2 - PRODUCTS

#### 2.1 MOP SINKS

- A. Mop Sink: Polypropylene composite or terrazzo molded stone structure, trap standard, free standing.
  - 1. Fixture:
    - a. ASME A112.19.3/CSA B45.4.
    - b. Type: With backsplash.
    - c. Number of Compartments: **One**
    - d. Compartment:
      - 1) Drain: Grid with NSP 2, tail piece and twist drain.
      - 2) Drain Location: Center



## 2.2 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

## 2.3 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
  - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
  - 2. Install stops in locations where they can be easily reached for operation.

- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

### 3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

### 3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

### 3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

## SECTION 224500 - EMERGENCY PLUMBING FIXTURES

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Eye/face wash equipment.

### 1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: Moderately warm.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- B. Field quality-control test reports.

### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing-Fluid Solution: Separate lot and equal to at least [200] <Insert number> percent of amount of solution installed for each self-contained unit.

## 1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities" [; **Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act";]** for plumbing fixtures for people with disabilities.

## PART 2 - PRODUCTS

### 2.1 EMERGENCY SHOWERS

### 2.2 EYE/FACE WASH EQUIPMENT

- A. Accessible, Wall-Mounted, Plumbed, Eye/Face Wash Units
  1. Capacity: Not less than **3.0 gpm** for at least 15 minutes.
  2. Supply Piping: **NPS 1/2** chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
  3. Control-Valve Actuator: Stainless steel push handle
  4. Spray-Head Assembly: Two receptor-mounted spray heads.
  5. Receptor: **stainless-steel** bowl.
  6. Mounting: Wall bracket.
  7. Special Construction: Comply with ANSI/ISEA Z358.1.

### 2.3 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping".
  - 1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- F. Fill self-contained fixtures with flushing fluid.

### 3.3 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

### 3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures.

### 3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION 224500

## SECTION 224713 - DRINKING FOUNTAINS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes drinking fountains and related components.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of drinking fountain.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include operating characteristics, and furnished specialties and accessories.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains to include in maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 DRINKING FOUNTAINS

- A. Drinking Fountains: Stainless steel, wall mounted with bottle filler for ADA.
  - 1. Stainless-Steel Drinking Fountains with bottle filler:
  - 2. Standards:
    - a. Comply with NSF/ANSI 61 & 372.
  - 3. Type Receptor: With back.
  - 4. Receptor Shape: Rectangular.
  - 5. Back Panel: Stainless-steel wall plate behind drinking fountain.
  - 6. Bubblers: One, with adjustable stream regulator, located on deck.
  - 7. Control: Mechanically activated, Hands free.
  - 8. Drain: Grid type with NPS 1-1/4 tailpiece.
  - 9. Supply: NPS 3/8 with shutoff valve.
  - 10. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.

11. Support: ASME A112.6.1M, Type III lavatory carrier.
12. Electronic Sensor operated bottle filler with front and side pushbar.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.
- F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

#### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping".
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."



3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224713

***DIVISION 23***

***HVAC***

## SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### 1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### PART 2 - PRODUCTS

#### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

#### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

#### 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

#### 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

#### 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
  2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
  2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

### PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel .

- B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

- C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel stainless steel.

#### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

### 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

### 2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

### 2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.



## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.
  - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
  - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
  - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

## SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraint channel bracings.
14. Restraint cables.
15. Seismic-restraint accessories.
16. Mechanical anchor bolts.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
  - 1. Basic Wind Speed: .
  - 2. Building Classification Category: .
  - 3. Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: .
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: .
    - a. Component Importance Factor: .
    - b. Component Response Modification Factor: .
    - c. Component Amplification Factor: .
  - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): .
  - 4. Design Spectral Response Acceleration at 1.0-Second Period: .

### 2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads: .
  - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 2. Size: Factory or field cut to match requirements of supported equipment.
  - 3. Pad Material: Oil and water resistant with elastomeric properties.
  - 4. Surface Pattern: Waffle pattern.
  - 5. Infused nonwoven cotton or synthetic fibers.
  - 6. Load-bearing metal plates adhered to pads.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts: .
  - 1. Mounting Plates:
    - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
  - 2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Restrained Elastomeric Isolation Mounts: .
  - 1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    - a. Housing: Cast-ductile iron or welded steel.
    - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
  - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  - 2. Maximum Load Per Support: 500 psigon isolation material providing equal isolation in all directions.

## 2.6 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
  - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.7 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .



1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.8 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
  2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

## 2.9 RESTRAINT CHANNEL BRACINGS

- A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.10 RESTRAINT CABLES

- A. Restraint Cables: ASTM A 603 galvanized ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

### 3.2 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
  - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 3. Install seismic-restraint devices using methods approved by that provides required submittals for component.
- E. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
  - 3. Brace a change of direction longer than 12 feet.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- K. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. Measure isolator restraint clearance.
  7. Measure isolator deflection.
  8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

### 3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.

- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 230548

## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

##### A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

##### B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  7. Fasteners: Stainless-steel rivets or self-tapping screws.
  8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

#### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 203 (1990; R 2011) Field Performance Measurements of Fan Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1 (2019; ADD A-G 2021; Errata 3 2021) Ventilation for Acceptable Indoor Air Quality

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (2002; 6th ed) National Standards for Total System Balance

AABC MN-4 (1996) Test and Balance Procedures

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV (2006) Procedural Standards for Measurements and Assessment of Sound and Vibration

NEBB PROCEDURAL STANDARDS (2015) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780 (2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition

SMACNA 1858 (2004) HVAC Sound And Vibration Manual - First Edition

SMACNA 1972 CD (2012) HVAC Air Duct Leakage Test Manual - 2nd Edition

1.2 DEFINITIONS

- a. AABC: Associated Air Balance Council
- b. Owner: Owner's Technical Representative



- c. DALT: Duct air leakage test
- d. DALT'd: Duct air leakage tested
- e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling
- f. NEBB: National Environmental Balancing Bureau
- g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report.  
When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."
- h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.
- i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.
- j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.
- k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).
- l. TAB: Testing, adjusting, and balancing (of HVAC systems)
- m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed
- n. TAB Agency: TAB Firm
- o. TAB team field leader: TAB team field leader
- p. TAB team supervisor: TAB team engineer
- q. TAB team technicians: TAB team assistants
- r. TABB: Testing Adjusting and Balancing Bureau

#### 1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

### 1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air and water distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

#### 1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Owner's written approval before applying insulation to exterior of air distribution systems as specified under Section 230700 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 1.3.2 Water Distribution Systems

TAB systems in compliance with this section. Obtain Owner's written approval before applying insulation to water distribution systems as specified under Section 230700 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Owner's written approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 230700 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 1.3.3 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.
2. Air quantities at air terminals.
3. Air quantities and temperatures in air handling unit schedules.
4. Water quantities and temperatures in thermal energy transfer equipment schedules.
5. Water quantities and heads in pump schedules.
6. Water flow measurement fittings and balancing fittings.
7. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications:

<http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables>

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Owner of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

Submit three copies of the TAB Schematic Drawings and Report Forms to the Owner, no later than 21 days prior to the start of TAB field measurements.

### 1.4 SUBMITTALS

Submit the following in accordance with Section 013300 SUBMITTAL PROCEDURES:

#### Preconstruction Submittals

Records of Existing Conditions

TAB Firm

Designation of TAB Team Assistants

Designation of TAB Team Engineer or TAB Specialist

Designation of TAB Team Field Leader

Shop Drawings

TAB Schematic Drawings and Report Forms

SD-03 Product Data

Equipment and Performance Data

TAB Related HVAC Submittals

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB team engineer and assistant.

TAB Procedures

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration

Systems Readiness Check

TAB Execution

TAB Verification

Test Reports

Completed Pre-Final DALT Report

Certified Final DALT Report

TAB Design Review Report

TAB Report; G

Certificates

Independent TAB Agency and Personnel Qualifications

DALT and TAB Submittal and Work Schedule

TAB Pre-Field Engineering Report

TAB Firm

Design Review Report

Pre-field DALT Preliminary Notification

Advanced Notice for TAB Field Work

Prerequisite HVAC Work Check Out List

## 1.5 QUALITY ASSURANCE

### 1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Owner for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Owner.

### 1.5.2 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB

Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

### 1.5.3 Qualifications

#### 1.5.3.1 TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Owner and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

#### 1.5.3.2 TAB Specialist

The TAB Specialist must be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Owner and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

#### 1.5.3.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process specified in Section 019100.15 TOTAL BUILDING COMMISSIONING.

#### 1.5.3.4 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Owner. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

#### 1.5.4 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

##### 1.5.4.1 Contractor

- a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.
- b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.
- c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:
  - (1) Contract drawings and specifications
  - (2) Approved submittal data for equipment
  - (3) Construction work schedule
  - (4) Up-to-date revisions and change orders for the previously listed items
- d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.
- e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

- f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Owner within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.
- g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.
- h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.
  - (1) HVAC system installations are fully complete.
  - (2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.
  - (3) DALT field checks for all systems are completed.
  - (4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.
- i. Advance notice: Furnish to the Owner with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.
- j. Insulation work: For required DALT work, ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

#### 1.5.4.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

#### 1.5.4.3 TAB Team Supervisor

- a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.
- b. Pre-DALT/TAB meeting: Attend meeting with Contractor.
- c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish



the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

- d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.
- e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Owner.
- f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.
- g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.
- h. Technical assistance for DALT work.
  - (1) Technical assistance: Provide immediate technical assistance to TAB field team.
  - (2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of one 8 hour workday duration.
- i. Final DALT report: Certify the DALT report. This certification includes the following work:
  - (1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.
  - (2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.
- j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.
  - (1) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.
- k. Certified TAB report: Certify the TAB report. This certification includes the following work:
  - (1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

- l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Owner, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.
- m. TAB Field Check: The TAB team supervisor must attend and supervise TAB field check.

#### 1.5.4.4 TAB Team Field Leader

- a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.
- b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.
- c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

#### 1.5.5 Test Reports

##### 1.5.5.1 Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

- a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.
- b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition, provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.
- c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.
- d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

### 1.5.5.2 Certified TAB Reports

Submit: TAB Report in the following manner:

- a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.
- b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded.
- c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.
- d. Static Pressure Profiles: Report static pressure profiles for air duct systems. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:
  - (1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.
  - (2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.
  - (3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.
- e. Duct Traverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."
- f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.
- g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

- h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.
- i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

## 1.6 SEQUENCING AND SCHEDULING

### 1.6.1 DALT and TAB Submittal and Work Schedule

Submit this schedule, and TAB Schematic Drawings, adapted for this particular contract, to the Owner for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for Owner approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

**Qualify TAB Personnel:** Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

**Pre-DALT/TAB Meeting:** Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

**Design Review Report:** Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

**Pre-Field DALT Preliminary Notification:** On completion of the duct installation for each system, notify the Owner in writing within 5 days after completion.

**Ductwork Selected for DALT:** Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

**DALT Field Work:** Within 48 hours of COTR's selection, complete DALT field work on selected.

**Submit Pre-final DALT Report:** Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

**DALT Work Field Check:** Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Owner.

**Submit Final DALT Report:** Within 15 calendar days after completion of successful DALT Work Field Check, submit TAB report.

**Pre-Field TAB Engineering Report:** Within 15 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

**Prerequisite HVAC Work Check Out List and Advanced Notice For TAB Field Work:** At a minimum of 115 calendar days prior to CCD, submit prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of TAB field work.

**TAB Field Work:** At a minimum of 90 calendar days prior to CCD, accomplish TAB field work.

Submit TAB Report: Within 15 calendar days after completion of TAB field work, submit TAB report.

TAB Field Check: 30 calendar days after Season 1 TAB report is approved by the Owner, conduct field check.

Complete TAB Work: Prior to CCD, complete all TAB work.

TAB Field Work: At a minimum of 90 calendar days prior to CCD, accomplish TAB field work; submit TAB report; and conduct field check.

Complete TAB Work: Prior to CCD, complete all TAB work .

#### 1.6.1.1 TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

#### 1.6.1.2 Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Owner in writing within 7 calendar days after completion.

#### 1.6.1.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

- (1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.
- (2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.
- (3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

- (1) Design data obtained from system drawings, specifications, and approved submittals.

- (2) Notations detailing additional data to be obtained from the contract site by the TAB field team.
  - (3) Designate the actual data to be measured in the TAB field work.
  - (4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.
- c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Owner prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

## 1.7 WARRANTY

Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 1 years from the date of Owner acceptance of the work; issued directly to the Owner. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Owner's Representative. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a 1 year contractor installation warranty.

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section.

### 3.2 PRE-DALT/TAB MEETING

Meet with the Owner's technical representative to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

### 3.3 DALT PROCEDURES

#### 3.3.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

#### 3.3.2 Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Owner in writing prior to the COTR's duct selection field visit.

#### 3.3.3 Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

#### 3.3.4 DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.

In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

#### 3.3.5 Completed Pre-Final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.

#### 3.3.6 Quality Assurance - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

### 3.3.7 Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

### 3.3.8 Certified Final DALT Report

On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Owner for approval.

### 3.3.9 Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

## 3.4 TAB PROCEDURES

### 3.4.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the the requirements of AABC MN-1 or SMACNA 1780 (TABB) and SMACNA 1858 (TABB),except as supplemented and modified by this section.

Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.

### 3.4.2 Preliminary Procedures



Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

### 3.4.3 TAB Air Distribution Systems

#### 3.4.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water, chilled water, DX and steam coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

- a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

- b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

#### 3.4.3.2 Air Handling Units

Air handling unit systems including fans (air handling unit fans, exhaust fans and winter ventilation fans), coils, ducts, plenums, mixing boxes, terminal units, variable air volume boxes, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

#### 3.4.3.3 Makeup Air Units

Makeup air unit systems including fans, coils, ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

#### 3.4.3.4 Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

### 3.4.4 TAB Water Distribution Systems

#### 3.4.4.1 Chilled Water

Chilled water systems including pumps, coils, system balance valves and flow measuring devices.

#### 3.4.4.2 Heating Hot Water

Heating hot water systems including boilers, hot water converters (e.g., heat exchangers), pumps, coils, system balancing valves and flow measuring devices.

#### 3.4.5 TAB Work on Performance Tests Without Seasonal Limitations

##### 3.4.5.1 Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.

##### 3.4.5.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

##### 3.4.5.3 Water Chillers

For water chillers, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

##### 3.4.5.4 Coils

Report heating and cooling performance capacity tests for hot water and chilled water for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

- a. For Central station air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units and central built-up units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing".

Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

- b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

#### 3.4.6 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Owner for direction.

#### 3.4.7 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Owner describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

#### 3.4.8 TAB Reports

After completion of the TAB work, prepare a pre-final TAB report using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Owner, the TAB work and the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP of this section.

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Owner.

#### 3.4.9 Quality Assurance - COTR TAB Field Acceptance Testing

##### 3.4.9.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

- Group 1: All chillers, boilers, return fans, computer room units, and air handling units (central stations).

Group 2: 25 percent of the VAV terminal boxes and associated diffusers and registers.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 5: 25 percent of the supply fans, exhaust fans, and pumps.

Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

#### 3.4.9.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to be found. This additional field testing is up and above the original 25 percent of the of reported data entries to be field tested.

If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

#### 3.4.9.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Owner approval of the TAB Report submitted.

### 3.5 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

### 3.6 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

END OF SECTION 230593

## SECTION 230716 - HVAC EQUIPMENT INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:

1. Heat exchangers.
2. Chilled-water pumps.
3. Dual-service heating and cooling pumps.
4. Heating, hot-water pumps.
5. Expansion/compression tanks.
6. Air separators.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail removable insulation at equipment connections.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Block Insulation: ASTM C 552, Type I.
  - 2. Special-Shaped Insulation: ASTM C 552, Type III.
  - 3. Board Insulation: ASTM C 552, Type IV.
  - 4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290,. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- H. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- J. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- L. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
- M. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  2. Service Temperature Range: Minus 20 to plus 180 deg F.
  3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  2. Service Temperature Range: Minus 20 to plus 180 deg F.
  3. Solids Content: 60 percent by volume and 66 percent by weight.
  4. Color: White.

## 2.5 SEALANTS

- A. Joint Sealants:



1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements,;
  2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements,;
  3. Materials shall be compatible with insulation materials, jackets, and substrates.
  4. Permanently flexible, elastomeric sealant.
  5. Service Temperature Range: Minus 100 to plus 300 deg F.
  6. Color: White or gray.
  7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
  2. Fire- and water-resistant, flexible, elastomeric sealant.
  3. Service Temperature Range: Minus 40 to plus 250 deg F.
  4. Color: Aluminum.
  5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
  2. Fire- and water-resistant, flexible, elastomeric sealant.
  3. Service Temperature Range: Minus 40 to plus 250 deg F.
  4. Color: White.
  5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

## 2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Adhesive: As recommended by jacket material manufacturer.
  2. Color: Color-code jackets based on system..
  3. Factory-fabricated tank heads and tank side panels.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  1. Finish and thickness are indicated in field-applied jacket schedules.
  2. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper .
  3. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  4. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.
    - b. Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.
    - d. Flange and union covers.
    - e. End caps.
    - f. Beveled collars.
    - g. Valve covers.
    - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

- E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.
- F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

## 2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 11.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 6.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  - 1. Width: 2 inches.
  - 2. Thickness: 6 mils.
  - 3. Adhesion: 64 ounces force/inch in width.
  - 4. Elongation: 500 percent.
  - 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  - 1. Width: 2 inches.
  - 2. Thickness: 3.7 mils.
  - 3. Adhesion: 100 ounces force/inch in width.
  - 4. Elongation: 5 percent.
  - 5. Tensile Strength: 34 lbf/inch in width.

- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Width: 3 inches.
  - 2. Film Thickness: 4 mils.
  - 3. Adhesive Thickness: 1.5 mils.
  - 4. Elongation at Break: 145 percent.
  - 5. Tensile Strength: 55 lbf/inch in width.
  
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Width: 3 inches.
  - 2. Film Thickness: 6 mils.
  - 3. Adhesive Thickness: 1.5 mils.
  - 4. Elongation at Break: 145 percent.
  - 5. Tensile Strength: 55 lbf/inch in width.

## 2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
  
- B. Insulation Pins and Hangers:
  - 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
    - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - b. Spindle: , fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  
  - 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
    - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    - b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  
  - 3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
    - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - b. Spindle: , fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    - c. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: .

## 2.11 CORNER ANGLES

- A. PVC Corner Angles: thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

### 3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

#### A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
  - a. Do not weld anchor pins to ASME-labeled pressure vessels.
  - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
  - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
  - d. Do not overcompress insulation during installation.
  - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
  - f. Impale insulation over anchor pins and attach speed washers.
  - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
  2. Fabricate boxes from \_\_\_\_\_, at least 0.040 inch thick.
  3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.4 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- D. Where PVDC jackets are indicated, install as follows:
1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows



for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.5 FINISHES

- A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
  1. Flat Acrylic Finish: finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.7 BREECHING INSULATION SCHEDULE

- A. Round, Exposed Breeching and Connector: High-temperature mineral-fiber , 3 inches thick and 3-lb/cu. ft. nominal density.
- B. Round, Concealed Breeching and Connector Insulation: High-temperature mineral-fiber , 3 inches thick and 3-lb/cu. ft. nominal density.

### 3.8 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. Chilled-water pump insulation shall be the following:
  - 1. Cellular Glass: 3 inches thick.
  - 2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
  - 3. Phenolic: 2 inches thick.
- D. Heat-Exchanger (Water-to-Water for Heating Service) Insulation: Mineral-fiber pipe and tank, 2 inches thick.
- E. Dual-service heating and cooling pump insulation shall be the following:
  - 1. Cellular Glass: 3 inches thick.
  - 2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- F. Heating-Hot-Water Pump Insulation: Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- G. Chilled-water expansion/compression tank insulation shall be the following:
  - 1. Cellular Glass: 1-1/2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
  - 4. Polyolefin: 1 inch thick.
- H. Dual-service heating and cooling expansion/compression tank insulation shall be the following:
  - 1. Cellular Glass: 1-1/2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
  - 4. Polyolefin: 1 inch thick.
- I. Heating-Hot-Water Expansion/Compression Tank Insulation: Mineral-Fiber Pipe and Tank: 1 inch thick.
- J. Chilled-water air-separator insulation shall be one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
  - 4. Polyolefin: 1 inch thick.
- K. Dual-service heating and cooling air-separator insulation shall be one of the following:
  - 1. Cellular Glass: 2 inches thick.

2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.
4. Polyolefin: 1 inch thick.

L. Heating-Hot-Water Air-Separator Insulation: Mineral-Fiber Pipe and Tank: thick.

### 3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Concealed:
  1. None.
- D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
  1. None.
- E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  1. None.
  2. Aluminum, with : 0.032 inch thick.

### 3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
  1. Aluminum, : thick.
- D. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  1. Aluminum, with : thick.

END OF SECTION 230716

## SECTION 230719 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Refrigerant suction and hot-gas piping, indoors and outdoors.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
  1. Block Insulation: ASTM C 552, Type I.
  2. Special-Shaped Insulation: ASTM C 552, Type III.
  3. Board Insulation: ASTM C 552, Type IV.
  4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  5. Preformed Pipe Insulation with Factory-Applied : Comply with ASTM C 552, Type II, Class 2.
  6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.
- G. Mineral-Fiber, Preformed Pipe Insulation:
  1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- H. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
- I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 4. Color: White.
  
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 3. Solids Content: 60 percent by volume and 66 percent by weight.
  - 4. Color: White.

## 2.5 SEALANTS

- A. Joint Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Permanently flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
  - 4. Color: White or gray.
  - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
  
- B. FSK and Metal Jacket Flashing Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 4. Color: Aluminum.
  - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
  
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 4. Color: White.
  - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
  5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  6. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

## 2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
  2. Color: .
  3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.



1. Finish and thickness are indicated in field-applied jacket schedules.
  2. Moisture Barrier for Indoor Applications: .
  3. Moisture Barrier for Outdoor Applications: .
  4. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.
    - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.
    - d. Flange and union covers.
    - e. End caps.
    - f. Beveled collars.
    - g. Valve covers.
    - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.
- F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

## 2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
  2. Thickness: 11.5 mils.
  3. Adhesion: 90 ounces force/inch in width.
  4. Elongation: 2 percent.
  5. Tensile Strength: 40 lbf/inch in width.
  6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
  2. Thickness: 6.5 mils.
  3. Adhesion: 90 ounces force/inch in width.
  4. Elongation: 2 percent.
  5. Tensile Strength: 40 lbf/inch in width.
  6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  - 1. Width: 2 inches.
  - 2. Thickness: 6 mils.
  - 3. Adhesion: 64 ounces force/inch in width.
  - 4. Elongation: 500 percent.
  - 5. Tensile Strength: 18 lbf/inch in width.
  
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  - 1. Width: 2 inches.
  - 2. Thickness: 3.7 mils.
  - 3. Adhesion: 100 ounces force/inch in width.
  - 4. Elongation: 5 percent.
  - 5. Tensile Strength: 34 lbf/inch in width.
  
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Width: 3 inches.
  - 2. Film Thickness: 4 mils.
  - 3. Adhesive Thickness: 1.5 mils.
  - 4. Elongation at Break: 145 percent.
  - 5. Tensile Strength: 55 lbf/inch in width.
  
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Width: 3 inches.
  - 2. Film Thickness: 6 mils.
  - 3. Adhesive Thickness: 1.5 mils.
  - 4. Elongation at Break: 145 percent.
  - 5. Tensile Strength: 55 lbf/inch in width.

## 2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy .

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Manholes.
  5. Handholes.
  6. Cleanouts.

### 3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.6 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### 3.7 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.



2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to <Insert number> locations of straight pipe, <Insert number> locations of threaded fittings, <Insert number> locations of welded fittings, <Insert number> locations of threaded strainers, <Insert number> locations of welded strainers, <Insert number> locations of threaded valves, and <Insert number> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric , 1 inch <Insert dimension> thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1 inch <Insert dimension> thick.

### 3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Insulation shall be the following:
  - 1. Flexible Elastomeric: 2 inches <Insert dimension> thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be the following:
  - 1. Flexible Elastomeric: 2 inches <Insert dimension> thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
- D. Piping, Exposed:
  - 1. None.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
- D. Piping, Exposed:
  - 1. PVC: 20 mils thick.
  - 2. <Insert jacket type>.

3.15 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719

## SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

#### 1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

##### C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- J. DOCSIS: Data-Over Cable Service Interface Specifications.
- K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- L. HLC: Heavy load conditions.
- M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- N. LAN: Local area network.
- O. LNS: LonWorks Network Services.
- P. LON Specific Definitions:
  - 1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
  - 2. LonMark: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
  - 3. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
  - 4. LonWorks: Network technology developed by Echelon.
  - 5. Node: Device that communicates using CEA-709.1-C protocol and that is connected to a CEA-709.1-C network.
  - 6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
  - 7. Node ID: A unique 48-bit identifier assigned at factory to each CEA-709.1-C device. Sometimes called a "Neuron ID."
  - 8. Program ID: An identifier (number) stored in a device (usually EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
  - 9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark International for configuration properties.
  - 10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network

Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").

11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
  12. TP/FT-10: Free Topology Twisted Pair network defined by CEA-709.3 and is most common media type for a CEA-709.1-C control network.
  13. TP/XF-1250: High-speed, 1.25-Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" typically used only to connect multiple TP/FT-10 networks.
  14. User-Defined Configuration Property Type (UCPT): Pronounced "U-Keep-It." A Configuration Property format type that is defined by device manufacturer.
  15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.
- Q. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- R. Modbus TCP/IP: An open protocol for exchange of process data.
- S. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- T. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
- U. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- V. PDA: Personal digital assistant.
- W. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- X. POT: Portable operator's terminal.
- Y. RAM: Random access memory.
- Z. RF: Radio frequency.
- AA. Router: Device connecting two or more networks at network layer.
- BB. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- CC. UPS: Uninterruptible power supply.
- DD. USB: Universal Serial Bus.

- EE. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- FF. VAV: Variable air volume.
- GG. WLED: White light emitting diode.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at .

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product include the following:
  1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
  3. Product description with complete technical data, performance curves, and product specification sheets.
  4. Installation, operation and maintenance instructions including factors effecting performance.
  5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
    - a. Operator workstations.
    - b. Servers.
    - c. Printers.
    - d. Gateways.
    - e. Routers.
    - f. Protocol analyzers.
    - g. DDC controllers.
    - h. Enclosures.
    - i. Electrical power devices.
    - j. UPS units.
    - k. Accessories.
    - l. Instruments.
    - m. Control dampers and actuators.
    - n. Control valves and actuators.
  6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
  7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

B. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

C. LEED Submittals:

1. Include supporting data showing energy, flow, gas, moisture, motion, pressure, and temperature instruments, where and if used in Project; and associated application for monitoring and control to satisfy requirements of Project LEED credits.
  - a. Indicate applicable locations and area coverage, control set points, description of control operation and other required information to satisfy submission requirements for award of LEED credit.
2. Organize and identify standalone, supporting data for each LEED credit.
3. Project LEED credits include the following:

D. Shop Drawings:

1. Include plans, elevations, sections, and mounting details where applicable.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail means of vibration isolation and show attachments to rotating equipment.
4. Plan Drawings indicating the following:
  - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
  - b. Room names and numbers with coordinated placement to avoid interference with control products indicated.



- c. Each desktop operator workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
  - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
  - e. Network communication cable and raceway routing.
  - f. Information, drawn to scale, of.
  - g. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.
5. Schematic drawings for each controlled HVAC system indicating the following:
- a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
  - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
  - c. A graphic showing location of control I/O in proper relationship to HVAC system.
  - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
  - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
  - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
  - g. Narrative sequence of operation.
  - h. Graphic sequence of operation, showing all inputs and output logical blocks.
6. Control panel drawings indicating the following:
- a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
  - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
  - c. Front, rear, and side elevations and nameplate legend.
  - d. Unique drawing for each panel.
7. DDC system network riser diagram indicating the following:
- a. Each device connected to network with unique identification for each.
  - b. Interconnection of each different network in DDC system.
  - c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
  - d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
8. DDC system electrical power riser diagram indicating the following:
- a. Each point of connection to field power with requirements (volts/phase/hertz/amperes/connection type) listed for each.

- b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
  - c. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
  - d. Power wiring type and size, race type, and size for each.
9. Monitoring and control signal diagrams indicating the following:
- a. Control signal cable and wiring between controllers and I/O.
  - b. Point-to-point schematic wiring diagrams for each product.
  - c. Control signal tubing to sensors, switches and transmitters.
  - d. Process signal tubing to sensors, switches and transmitters.
10. Color graphics indicating the following:
- a. Itemized list of color graphic displays to be provided.
  - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
  - c. Intended operator access between related hierarchical display screens.
- E. System Description:
1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
  2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
  3. System and product operation under each potential failure condition including, but not limited to, the following:
    - a. Loss of power.
    - b. Loss of network communication signal.
    - c. Loss of controller signals to inputs and outputs.
    - d. Operator workstation failure.
    - e. Gateway failure.
    - f. Network failure
    - g. Controller failure.
    - h. Instrument failure.
    - i. Control damper and valve actuator failure.
  4. Complete bibliography of documentation and media to be delivered to Owner.
  5. Description of testing plans and procedures.
  6. Description of Owner training.
- F. Samples:
1. For each exposed product, installed in finished space for approval of selection of aesthetic characteristics.

- G. Delegated-Design Submittal: For DDC system products and installation indicated as being delegated.
1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
  2. Schedule and design calculations for control dampers and actuators.
    - a. Flow at Project design and minimum flow conditions.
    - b. Face velocity at Project design and minimum airflow conditions.
    - c. Pressure drop across damper at Project design and minimum airflow conditions.
    - d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    - e. Maximum close-off pressure.
    - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.
    - i. Actuator signal to control damper (on, close or modulate).
    - j. Actuator position on loss of power.
    - k. Actuator position on loss of control signal.
  3. Schedule and design calculations for control valves and actuators.
    - a. Flow at Project design and minimum flow conditions.
    - b. Pressure-differential drop across valve at Project design flow condition.
    - c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
    - d. Design and minimum control valve coefficient with corresponding valve position.
    - e. Maximum close-off pressure.
    - f. Leakage flow at maximum system pressure differential.
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.
    - i. Actuator signal to control damper (on, close or modulate).
    - j. Actuator position on loss of power.
    - k. Actuator position on loss of control signal.
  4. Schedule and design calculations for selecting flow instruments.
    - a. Instrument flow range.
    - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
    - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
    - d. Pressure-differential loss across instrument at Project design flow conditions.
    - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings, reflected ceiling plan(s), and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Qualification Data:
  - 1. Systems Provider Qualification Data:
    - a. Resume of project manager assigned to Project.
    - b. Resumes of application engineering staff assigned to Project.
    - c. Resumes of installation and programming technicians assigned to Project.
    - d. Resumes of service technicians assigned to Project.
    - e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
    - f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
    - g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
    - h. Owner contact information for past project including name, phone number, and e-mail address.
    - i. Contractor contact information for past project including name, phone number, and e-mail address.
    - j. Architect contact information for past project including name, phone number, and e-mail address.
  - 2. Manufacturer's qualification data.
  - 3. Testing agency's qualifications data.
- C. Welding certificates.
- D. Product Certificates:
  - 1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.
  - 2. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with LonWorks.
- E. Product Test Reports: For each product that requires testing to be performed by .
- F. Preconstruction Test Reports: For each separate test performed.
- G. Source quality-control reports.
- H. Field quality-control reports.
- I. Sample Warranty: For manufacturer's warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
    - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
    - c. As-built versions of submittal Product Data.
    - d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
    - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
    - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
    - g. Engineering, installation, and maintenance manuals that explain how to:
      - 1) Design and install new points, panels, and other hardware.
      - 2) Perform preventive maintenance and calibration.
      - 3) Debug hardware problems.
      - 4) Repair or replace hardware.
    - h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
    - i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
    - j. List of recommended spare parts with part numbers and suppliers.
    - k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
    - l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
    - m. Licenses, guarantees, and warranty documents.
    - n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
    - o. Owner training materials.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- B. Include product manufacturers' recommended parts lists for proper product operation over -year period following warranty period. Parts list shall be indicated for each year.
- C. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
  - 1. Network Controller: One.
  - 2. Programmable Application Controller: One.
  - 3. Application-Specific Controller: One.
  - 4. Carbon Dioxide Sensor and Transmitter: .
  - 5. Room Moisture Sensor and Transmitter: One.
  - 6. Pressure Sensor and Transmitter: .
  - 7. Room Temperature Sensor and Transmitter: One.
  - 8. Multifunction Time-Delay Relay: One.

## 1.8 QUALITY ASSURANCE

- A. DDC System Manufacturer Qualifications:
  - 1. Nationally recognized manufacturer of DDC systems and products.
  - 2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
  - 3. DDC systems and products that have been successfully tested and in use on at least three past projects.
  - 4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
  - 5. Having full-time in-house employees for the following:
    - a. Product research and development.
    - b. Product and application engineering.
    - c. Product manufacturing, testing and quality control.
    - d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
    - e. Owner operator training.
- B. DDC System Provider Qualifications:
  - 1. Authorized representative of, and trained by, DDC system manufacturer.
  - 2. In-place facility located within of Project.
  - 3. Demonstrated past experience with installation of DDC system products being installed for period within three consecutive years before time of bid.
  - 4. Demonstrated past experience on five projects of similar complexity, scope and value.
  - 5. Each person assigned to Project shall have demonstrated past experience.
  - 6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
  - 7. Service and maintenance staff assigned to support Project during warranty period.
  - 8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.

9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.
- C. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  4. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."
- E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 1.9 WARRANTY
- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
  2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
    - a. Install updates only after receiving Owner's written authorization.
  3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
  4. Warranty Period: Two year(s) from date of Substantial Completion.
    - a. For Gateway: Two -year parts and labor warranty for each.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

### 2.2 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system shall consist of a peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 WEB ACCESS

- A. DDC system shall be Web compatible.
  1. Web-Compatible Access to DDC System:
    - a. Operator workstation shall perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
    - b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.
    - c. Web access shall be password protected.

## 2.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.
  1. System Performance Objectives:
    - a. DDC system shall manage HVAC systems.
    - b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
    - c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
    - d. DDC system shall operate while unattended by an operator and through operator interaction.
    - e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.
  - B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    1. Flame-Spread Index: 25 or less.
    2. Smoke-Developed Index: 50 or less.
  - C. DDC System Speed:
    1. Response Time of Connected I/O:



- a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
  - b. BI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
  - c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
  - d. BO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
2. Display of Connected I/O:
- a. Analog point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
  - b. Binary point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
  - c. Alarms of analog and digital points connected to DDC system shall be displayed within 15 seconds of activation or change of state.
  - d. Graphic display refresh shall update within four seconds.
  - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
- D. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- E. DDC System Data Storage:
1. Include server(s) with disk drive data storage to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
  2. When logged onto a server, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
  3. Server(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
  4. Server(s) shall use IT industry-standard database platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE).
- F. Future Expandability:
1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.

2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
  3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.
- G. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.
1. Energy:
    - a. Thermal: Within 3 percent of reading.
    - b. Electric Power: Within 1 percent of reading.
    - c. Requirements indicated on Drawings for meters not supplied by utility.
  2. Flow:
    - a. Air: Within 5 percent of design flow rate.
    - b. Air (Terminal Units): Within 10 percent of design flow rate.
    - c. Water: Within 5 percent of design flow rate.
  3. Gas:
    - a. Carbon Monoxide: Within 5 percent of reading.
    - b. Nitrogen Dioxide: Within 5 percent of reading.
    - c. Refrigerant: Within 50 ppm.
  4. Moisture (Relative Humidity):
    - a. Air: Within 5 percent RH.
    - b. Space: Within 5 percent RH.
    - c. Outdoor: Within 5 percent RH.
  5. Level: Within percent of reading.
  6. Pressure:
    - a. Air, Ducts and Equipment: 1 percent of instrument span.
    - b. Space: Within 1 percent of instrument span.
    - c. Water: Within 1 percent of instrument span.
    - d. Steam: Within 1 percent of instrument span.
  7. Speed: Within 5 percent of reading.
  8. Temperature, Dew Point:
    - a. Air: Within 1 deg F.
    - b. Space: Within 1 deg F.
    - c. Outdoor: Within 3 deg F.
  9. Temperature, Dry Bulb:

- a. Air: Within 1 deg F.
  - b. Space: Within 1 deg F.
  - c. Outdoor: Within 2 deg F.
  - d. Temperature Difference: Within 0.25 deg F.
  - e. Other Temperatures Not Indicated: Within 1 deg F.
10. Temperature, Wet Bulb:
- a. Air: Within 1 deg F.
  - b. Space: Within 1 deg F.
  - c. Outdoor: Within 2 deg F.
11. Vibration: Within 10 percent of reading.
- H. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:
1. Current:
    - a. Milliamperes: Nearest 1/100th of a milliampere.
    - b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
  2. Energy:
    - a. Electric Power:
      - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
      - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
      - 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
    - b. Thermal, Rate:
      - 1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
      - 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.
    - c. Thermal, Usage:
      - 1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.

- 2) Cooling: For ton-hours, nearest ton-hours up to 1000 tons-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.
3. Flow:
  - a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
  - b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
  - c. Steam: Nearest 1/10th lb/hr through 100 lbs/hr; nearest lbs/hr between 100 and 1000 lbs/hr; nearest 10 lbs/hr above 1000 lbs/hr.
4. Gas:
  - a. Carbon Dioxide (ppm): Nearest ppm.
  - b. Carbon Monoxide (ppm): Nearest ppm.
  - c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
  - d. Refrigerant (ppm): Nearest ppm.
5. Moisture (Relative Humidity):
  - a. Relative Humidity (Percentage): Nearest 1 percent.
6. Level: Nearest 1/100th of an inch through 10 inches, nearest 1/10 of an inch between 10 and 100 inches, nearest inch above 100 inches.
7. Speed:
  - a. Rotation (rpm): Nearest 1 rpm.
  - b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.
8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:
  - a. Air, Ducts and Equipment: Nearest 1/10th in. w.c..
  - b. Space: Nearest 1/100th in. w.c. (Nearest 1/10th Pa).
  - c. Steam: Nearest 1/10th psig through 100 psig, nearest psig above 100 psig.
  - d. Water: Nearest 1/10 psig through 100 psig, nearest psig above 100 psig.
10. Temperature:
  - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
  - b. Outdoor: Nearest degree.
  - c. Space: Nearest 1/10th of a degree.
  - d. Chilled Water: Nearest 1/10th of a degree.
  - e. Condenser Water: Nearest 1/10th of a degree.
  - f. Heating Hot Water: Nearest degree.
  - g. Heat Recovery Runaround: Nearest 1/10th of a degree.

- h. Steam: Nearest degree.
  - 11. Vibration: Nearest 1/10th in/s.
  - 12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.
- I. Control Stability: Control variables indicated within the following limits:
- 1. Flow:
    - a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
    - b. Air, Terminal Units: Within 10 percent of design flow rate.
    - c. Water: Within 5 percent of design flow rate.
  - 2. Gas:
    - a. Nitrogen Dioxide: Within 5 percent of reading.
    - b. Carbon Monoxide: Within 5 percent of reading.
  - 3. Moisture (Relative Humidity):
    - a. Air: Within 2 percent RH.
    - b. Space: Within 2 percent RH.
    - c. Outdoor: Within 2 percent RH.
  - 4. Level: Within 5 percent of reading.
  - 5. Pressure:
    - a. Air, Ducts and Equipment: 1 percent of instrument span.
    - b. Space: Within 1 percent of instrument span.
    - c. Water: Within 1 percent of instrument span.
    - d. Steam: Within 1 percent of instrument span.
  - 6. Temperature, Dew Point:
    - a. Air: Within 1 deg F.
    - b. Space: Within 1 deg F.
  - 7. Temperature, Dry Bulb:
    - a. Air: Within 2 deg F.
    - b. Space: Within 2 deg F.
    - c. Chilled Water: Within 1 deg F.
    - d. Condenser Water: Within 1 deg F.
    - e. Heating Hot Water: Within 2 deg F.
    - f. Energy Recovery Runaround Liquid: Within 1 deg F.
  - 8. Temperature, Wet Bulb:
    - a. Air: Within 1 deg F.
    - b. Space: Within 1 deg F.

J. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
  - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
  - a. Outdoors, Protected: Type 3.
  - b. Outdoors, Unprotected: Type 4X.
  - c. Indoors, Heated with Filtered Ventilation: Type 2.
  - d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
  - e. Indoors, Heated and Air Conditioned: Type 1.
  - f. Mechanical Equipment Rooms:
    - 1) Air-Moving Equipment Rooms: Type 12.
  - g. Localized Areas Exposed to Washdown: Type 4X.
  - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3.
  - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
  - j. Hazardous Locations: Explosion-proof rating for condition.

K. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
  - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and ventilated as required by instrument and application.
2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
  - a. Outdoors, Protected: Type 3 .
  - b. Outdoors, Unprotected: Type 4X.

- c. Indoors, Heated with Filtered Ventilation: Type 2.
- d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
- e. Indoors, Heated and Air-conditioned: Type 1.
- f. Mechanical Equipment Rooms:
  - 1) Air-Moving Equipment Rooms: Type 12.
- g. Localized Areas Exposed to Washdown: Type 4X.
- h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3 .
- i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4 .
- j. Hazardous Locations: Explosion-proof rating for condition.

L. Electric Power Quality:

1. Power-Line Surges:

- a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
- b. Do not use fuses for surge protection.
- c. Test protection in the normal mode and in the common mode, using the following two waveforms:
  - 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
  - 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

- a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
  - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
  - 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
  - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
  - 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

M. Backup Power Source:

- 1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

N. UPS:

1. DDC system products powered by UPS units shall include the following:
  - a. Desktop operator workstations.
  - b. Printers.
  - c. Servers.
  - d. Gateways.
  - e. DDC controllers.
2. DDC system instruments and actuators powered by UPS units shall include the following:
  - a. Instruments associated with the following systems controlled by DDC system:
  - b. Dampers and actuators associated with the following systems controlled by DDC system:
  - c. Valves and actuators associated with the following systems controlled by DDC system:

O. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

## 2.5 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than three levels of LANs.

1. Level one LAN shall connect network controllers and operator workstations.
2. Level two LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
3. Level three LAN shall connect application-specific controllers to programmable application controllers and network controllers.
4. Level three LAN shall connect application-specific controllers to application-specific controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Application Controllers: 1000 kbps.
3. LAN Connecting Application-Specific Controllers: 115,000 bps.

C. DDC system shall consist of dedicated LANs that are not shared with other building systems and tenant data and communication networks.



- D. System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated.
- E. System architecture shall perform modifications without having to remove and replace existing network equipment.
- F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.
- G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.
- H. Special Network Architecture Requirements:
  - 1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s). Basically, create a DDC system LAN that aligns with air-handling system being controlled.

## 2.6 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
  - 1. Desktop and portable operator workstation with hardwired connection through LAN port.
  - 2. Portable operator terminal with hardwired connection through LAN port.
  - 3. Portable operator workstation with wireless connection through LAN router.
  - 4. PDA with wireless connection through LAN router.
  - 5. Remote connection using outside of system personal computer or PDA through Web access.
  - 6. Remote connection using portable operator workstation and telephone dial-up modem.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable operator workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:
  - 1. Each mechanical equipment room.
  - 2. Each boiler room.
  - 3. Each chiller room or outdoor chiller yard.
  - 4. Each cooling tower location.
  - 5. Each different roof level with roof-mounted air-handling units or rooftop units.
  - 6. Security system command center.
  - 7. Fire-alarm system command center.
- D. Desktop Workstations:

1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.
3. Able to communicate, with modems, remotely with any device connected to any DDC system LAN.
4. Communication via a modem shall not interfere with LAN activity and LAN activity shall not prevent workstation from handling incoming calls.

E. Portable Workstations:

1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.
3. Connect to DDC system Level two or Level three LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
4. Connect to system through a wireless router connected to Level one LAN.
5. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
6. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
7. Have dynamic graphic displays that are identical to desktop workstations.

F. POT:

1. Connect DDC controller through a communications port local to controller.
2. Able to communicate with any DDC system controller that is directly connected or connected to DDC system.

G. Personal Digital Assistant:

1. Connect to system through a wireless router connected to LAN.
2. Able to communicate with any DDC controller connected to DDC system.

H. Telephone Communications:

1. Through use of a standard modem, operator shall be able to communicate with any device connected to any system LAN.
2. Have auto-dial and auto-answer communications to allow desktop and portable workstations and DDC controllers to communicate with remote workstations and remote DDC controllers via telephone lines.

a. Desktop and Portable Operator Workstation Computers with Modems:

- 1) Operators shall be able to perform all control functions, report functions, and database generation and modification functions as if directly connected to system LAN.
- 2) Have routines to automatically answer calls, and either file or display information sent remotely.
- 3) Communications taking place over telephone lines shall be completely transparent to operator.

- 4) Dial-up program shall maintain a user-definable cross-reference and associated telephone numbers so it is not required to remember or manually dial telephone numbers.

b. DDC Controllers:

- 1) Not have modems unless specifically indicated for a unique controller.
- 2) Controllers with modems shall automatically place calls to report critical alarms, or to upload trend and historical information for archiving.
- 3) Analyze and prioritize alarms to minimize initiation of calls.
- 4) Buffer noncritical alarms in memory and report them as a group of alarms, or until an operator manually requests an upload.
- 5) Make provisions for handling busy signals, no-answers, and incomplete data transfers.
- 6) Call default devices when communications cannot be established with primary devices.

I. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message, and prerecorded phone message to mobile and landline phone numbers.

J. Simultaneous Operator Use: Capable of accommodating up to simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

## 2.7 NETWORKS

A. Acceptable networks for connecting operator workstations and network controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable application controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting application-specific controllers include the following:

1. ATA 878.1, ARCNET.

2. CEA-709.1-C.
3. EIA-485A.
4. IP.
5. IEEE 8802-3, Ethernet.

## 2.8 NETWORK COMMUNICATION PROTOCOL

- A. Network communication protocol(s) used throughout entire DDC system shall be open to public and available to other companies for use in making future modifications to DDC system.
- B. ASHRAE 135 Protocol:
  1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
  2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
  3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
  4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.
- C. CEA-709.1-C Protocol:
  1. DDC system shall be an open implementation of LonWorks technology using CEA 709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for communication throughout DDC system.
  2. LNS shall be used for all network management including addressing and binding of network variables.
    - a. Final LNS database shall be submitted with Project closeout submittals.
    - b. All devices shall be online and commissioned into LNS database.
  3. All devices connected to DDC system network(s) shall use CEA-709.1-C protocol and be installed so SCPT output from any node on network can be bound to any other node in the domain.
- D. Industry Standard Protocols:
  1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
    - a. ASHRAE 135.
    - b. CEA-709.1-C.
    - c. Modbus Application Protocol Specification V1.1b.
  2. Operator workstations and network controllers shall communicate through ASHRAE 135 protocol.

3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
4. Portions of DDC system networks using CEA-709.1-C communication protocol shall be an open implementation of LonWorks technology using CEA-709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Portions of DDC system networks using Modbus Application Protocol Specification V1.1b communication protocol shall be an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.
6. Gateways shall be used to connect networks and network devices using different protocols.

## 2.9 DESKTOP OPERATOR WORKSTATIONS

### A. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

### B. Personal Computer:

1. Minimum Processor Speed: .
2. RAM:
  - a. Capacity: 24 GB.
  - b. Speed and Type: 1333 MHz,.
  - c. Expandable Capacity: 72 GB.
3. Hard Drive:
  - a. Number of Hard Drives: One .
  - b. Capacity: .
  - c. Minimum Average Seek Time: .
  - d. Cache Buffer Size: .
4. Optical Drive:
  - a. Type: .
  - b. Minimum Average Access Time: ms.
  - c. Data Transfer Speed: /s.
  - d. Reading Formats: Data, audio, recordable, and rewritable.
5. Optical Read and Write Drive:
  - a. Include with at least 2 MB of data buffer.
  - b. Type: .
  - c. Minimum Data Buffer Capacity: .

- d. Minimum Average Access Time: ms.
  - e. Nominal Data Transfer Rates:
    - 1) Reading: /s.
    - 2) Writing: /s.
  - f. Average access time of 150 ms or less.
  - g. MTBF of at least 100,000 power-on hours.
6. At least four expansion slots of 32 bit.
7. Video Card:
- a. Resolution: pixels.
  - b. RAM: GB.
  - c. Controller Speed: .
  - d. On-Board Memory Speed: .
  - e. On-Board Memory Data Width: bit.
8. Sound Card:
- a. At least 128 voice wavetable synthesis.
  - b. Capable of delivering three-dimensional sound effects.
  - c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
9. Network Interface Card: Include card with connection, as applicable.
- a. 10-100-1000 base TX Ethernet with RJ45 connector port.
  - b. 100 base FX Ethernet with SC or ST port.
10. Cable Modem:
- a. Mbps.
  - b. Certified to comply with DOCSIS Cable Modem to Customer Premise Equipment Interface Specification, Version 3.0 and backward compatible with earlier versions.
  - c. Ethernet connectivity.
11. Optical Modem: Full duplex link for connection to fiber-optic cable provided.
12. I/O Ports:
- a. Two second-generation USB 2.0 ports on front panel, six on back panel, and three internal on motherboard.
  - b. One serial port.
  - c. One parallel port.
  - d. Two PS/2 ports.
  - e. One RJ-45.
  - f. One stereo line-in and headphone line-out on back panel.
  - g. One microphone and headphone connector on front panel.
  - h. One IEEE 1394 on front and back panel with PCI-e card.
  - i. One ESATA port on back panel.

13. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

C. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to 72 inches in front of workstation.

D. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to 72 inches in front of workstation.

E. Flat Panel Display Monitor:

1. Display:
  - a. Color display with diagonal viewable area.
  - b. input signal.
  - c. Aspect Ratio: .
  - d. Antiglare display.
  - e. Response Time: ms.
  - f. Dynamic Contrast Ratio: .
  - g. Brightness: .
  - h. Tilt adjustable base.
  - i. Energy Star compliant.
  - j. Resolution: pixels at 60 Hz with pixel size of mm or smaller.
  - k. Number of Displays: .

F. Speakers:

1. Two, with individual controls for volume, bass and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

G. I/O Cabling: Include applicable cabling to connect I/O devices.

## 2.10 PORTABLE OPERATOR WORKSTATIONS

A. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
3. Hardware and software shall support local down-loading to DDC controllers.
4. Data transfer rate to DDC controller shall be at network speed.

B. Processor:

1. Minimum Processor Speed: .
2. RAM:
  - a. Capacity: GB.
  - b. Speed and Type: MHz,.
  - c. Expandable Capacity: GB.
3. Hard Drive:
  - a. Number of Hard Drives: One .
  - b. Capacity: .
  - c. Minimum Average Seek Time: .
  - d. Cache Buffer Size: .
4. Video Card: of RAM.

C. Input and Output Ports:

1. Serial port.
2. Shared port for external keyboard or mouse.
3. Four USB 2.0 ports.
4. Ethernet port.
5. IEEE 1394 integrated port.
6. Serial infrared communications port.

D. Battery:

1. 9-cell, 81 Wh lithium ion battery and ac adapter.
2. Battery life of at least three years.
3. Battery charge time of less than three hours.
4. Spare Battery(ies). One.

E. Keyboard:

1. 85-key keyboard.
2. Full upper- and lowercase ASCII keyset.

F. Integral Pointing Device: Touchpad with two buttons or equivalent pointing device.

G. Display:

1. diagonal or larger high-definition WLED color display.
2. Antiglare screen.
3. 1920 by 1080 pixel resolution.
4. Brightness: 300 nits.

H. Network Interface Card: Include card with connection, as application.

1. 10-100-1000 base TX Ethernet with RJ45 connector port.



2. 100 base FX Ethernet with SC or ST port.

I. Digital Video Disc Rewrite Recorder (DVD+/-RW):

1. Compatible with DVD disks and data, audio, recordable and rewritable compact disks.
2. Nominal Data Transfer Rates:
  - a. Reading: /s.
  - b. Writing: /s.
3. 160-ms access time.

J. Accessories:

1. Leather carrying case.
2. Docking station.
3. Wireless-N communication card.
4. Bluetooth module with 2.1 standard technologies.
5. Mobile broadband card.
6. Wireless optical mouse.
7. portable hard drive.
8. Light-sensitive Web cam and noise-cancelling digital array microphone.
9. Cable with network jackets on each end. Minimum cable length shall be.

2.11 POT

- A. Description: Handheld device with integral keypad or touch screen operator interface.
- B. Display: Multiple lines of text display for use in operator interaction with DDC system.
- C. Cable: Flexible cable, at least 36 inches long, with a plug-in jack for connection to DDC controllers, network ports or instruments with an integral LAN port. As an alternative to hardwired connection, POT shall be accessible to DDC controllers through a wireless network connection.
- D. POT shall be powered through network connection.
- E. Connection of POT to DDC system shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.
- F. POT shall give operator the ability to do the following:
  1. Display and monitor BI point status.
  2. Change BO point set point (on or off, open or closed).
  3. Display and monitor analog point values.
  4. Change analog control set points.
  5. Command a setting of AO point.
  6. Display and monitor I/O point in alarm.
  7. Add a new or delete an existing I/O point.

8. Enable and disable I/O points, initiators, and programs.
9. Display and change time and date.
10. Display and change time schedules.
11. Display and change run-time counters and run-time limits.
12. Display and change time and event initiation.
13. Display and change control application and DDC parameters.
14. Display and change programmable offset values.
15. Access DDC controller initialization routines and diagnostics.

## 2.12 PRINTERS

### A. Color Inkjet Printer:

1. Inkjet technology with true four-color printing (black, cyan, magenta, and yellow).
2. Print quality of 1200 by 600 dots per inch with black on inkjet paper and 4800 by 1200 dots per inch color printing on premium photo paper.
3. Rated speed of pages per minute printing black and white in normal mode and pages per minute printing color in normal mode.
4. Two paper trays; one tray with sheet capacity, and one tray with sheet capacity.
5. Capable of handling letter- and legal-size paper and overhead transparencies.
6. MB of RAM.
7. Duplex printing (printing on both sides of paper).

## 2.13 SYSTEM SOFTWARE

### A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple-network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

### B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.

2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:
  - a. Operator access to DDC system shall be under password control.
  - b. An alphanumeric password shall be field assignable to each operator.
  - c. Operators shall be able to access DDC system by entry of proper password.
  - d. Operator password shall be same regardless of which computer or other interface means is used.
  - e. Additions or changes made to passwords shall be updated automatically.
  - f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
  - g. Software shall have at least five access levels.
  - h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
  - i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
7. Data Segregation:
  - a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
  - b. Include at least 32 segregation groups.
  - c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
  - d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
  - e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
  - f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.
8. Operators shall be able to perform commands including, but not limited to, the following:
  - a. Start or stop selected equipment.
  - b. Adjust set points.
  - c. Add, modify, and delete time programming.
  - d. Enable and disable process execution.
  - e. Lock and unlock alarm reporting for each point.
  - f. Enable and disable totalization for each point.
  - g. Enable and disable trending for each point.
  - h. Override control loop set points.

- i. Enter temporary override schedules.
  - j. Define holiday schedules.
  - k. Change time and date.
  - l. Enter and modify analog alarm limits.
  - m. Enter and modify analog warning limits.
  - n. View limits.
  - o. Enable and disable demand limiting.
  - p. Enable and disable duty cycle.
  - q. Display logic programming for each control sequence.
9. Reporting:
- a. Generated automatically and manually.
  - b. Sent to displays, printers and disk files.
  - c. Types of Reporting:
    - 1) General listing of points.
    - 2) List points currently in alarm.
    - 3) List of off-line points.
    - 4) List points currently in override status.
    - 5) List of disabled points.
    - 6) List points currently locked out.
    - 7) List of items defined in a "Follow-Up" file.
    - 8) List weekly schedules.
    - 9) List holiday programming.
    - 10) List of limits and deadbands.
10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.

9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
18. Points shall be dynamic with operator adjustable update rates on a per point basis from second to over a .
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
  - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
  - b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
  - c. Keyboard equivalent shall be available for those operators with that preference.
20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:
  - a. On-line context-sensitive help utility to facilitate operator training and understanding.
  - b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.
    - 1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.
  - c. Available for Every Menu Item:
    - 1) Index items for each system menu item.

22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.
  - a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols.
  - b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
    - 1) Define background screens.
    - 2) Define connecting lines and curves.
    - 3) Locate, orient and size descriptive text.
    - 4) Define and display colors for all elements.
    - 5) Establish correlation between symbols or text and associated system points or other displays.
- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
  1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
  2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
    - a. Room layouts with room identification and name.
    - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
    - c. Location and identification of each hardware point being controlled or monitored by DDC system.
  3. Control schematic for each of following, including a graphic system schematic representation with point identification, set point and dynamic value indication .
    - a. Energy-recovery system and unit.
    - b. Fuel system.
    - c. Air-handling system and unit.
    - d. Fan.
  4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
  5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers,.
- E. Customizing Software:
  1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
  2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
  3. As a minimum, include the following modification capability:
    - a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.

- b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
  - c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
  - d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
  - e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
  - f. Point related change capability shall include the following:
    - 1) System and point enable and disable.
    - 2) Run-time enable and disable.
    - 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
    - 4) Assignment of alarm and warning limits.
  - g. Application program change capability shall include the following:
    - 1) Enable and disable of software programs.
    - 2) Programming changes.
    - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.
4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
- a. Proportional control (P).
  - b. Proportional plus integral (PI).
  - c. Proportional plus integral plus derivative (PID).
  - d. Adaptive and intelligent self-learning control.
- 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.

- 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:
  - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
  - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
  - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
  - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.
  - a. Class 1:
    - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
    - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
    - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.



- b. Class 2:
    - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
    - 2) Acknowledgement may be through a multiple alarm acknowledgment.
  - c. Class 3:
    - 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
    - 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
    - 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgment.
    - 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
  - d. Class 4:
    - 1) Routine maintenance or other types of warning alarms.
    - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
  - 9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
  - 10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.
- G. Reports and Logs:
- 1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
  - 2. Each report shall be definable as to data content, format, interval and date.
  - 3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on server for historical reporting.
  - 4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
  - 5. Reports and logs shall be stored on workstation and server hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
  - 6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.
- H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
- 1. All I/O: With current status and values.
  - 2. Alarm: All current alarms, except those in alarm lockout.
  - 3. Disabled I/O: All I/O points that are disabled.
  - 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.

5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:
  - a. Alarm history.
  - b. System messages.
  - c. System events.
  - d. Trends.
- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.
- J. Standard Trends:
  1. Trend all I/O point present values, set points, and other parameters indicated for trending.
  2. Trends shall be associated into groups, and a trend report shall be set up for each group.
  3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching of DDC controller buffer limit, or by operator request, or by archiving time schedule.
  4. Preset trend intervals for each I/O point after review with Owner.
  5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
  6. When drive storage memory is full, most recent data shall overwrite oldest data.
  7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- K. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
  1. Each trend shall include interval, start time, and stop time.
  2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on hard drives.
  3. Data shall be retrievable for use in spreadsheets and standard database programs.
- L. Programming Software:
  1. Include programming software to execute sequences of operation indicated.
  2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
  3. Programming software shall be one of the following:
    - a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.
      - 1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
      - 2) Programming tools shall be viewable in real time to show present values and logical results of each function block.

- b. Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements and constraints.
  - c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.
4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

M. Database Management Software:

1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
  - a. Backup.
  - b. Purge.
  - c. Restore.
4. Database management software shall support the following:
  - a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
  - b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
  - c. Backup: Include means to create a database backup file and select a storage location.
  - d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.
5. Database management software shall include information of current database activity, including the following:
  - a. Ready.
  - b. Purging record from a database.
  - c. Action failed.
  - d. Refreshing statistics.
  - e. Restoring database.
  - f. Shrinking a database.
  - g. Backing up a database.
  - h. Resetting Internet information services.
  - i. Starting network device manager.
  - j. Shutting down the network device manager.
  - k. Action successful.

6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:
  - a. Allow operator to set and review scan intervals and start times.
  - b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
  - c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
  - d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
  - e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.
9. Monitoring settings taskbar shall include the following informational icons:
  - a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
  - b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
  - c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

#### 2.14 OFFICE APPLICATION SOFTWARE

- A. Include current version of office application software at time of Substantial Completion.
- B. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft's "Office Professional."
  1. Database.
  2. E-mail.
  3. Presentation.
  4. Publisher.
  5. Spreadsheet.
  6. Word processing.

#### 2.15 ASHRAE 135 GATEWAYS

- A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, and variable-speed drives.
- B. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.

- C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.
- D. Gateway Minimum Requirements:
  - 1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
  - 2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
  - 3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
  - 4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
  - 5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
  - 6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

## 2.16 CEA-709.1-C NETWORK HARDWARE

### A. Routers:

- 1. Network routers, including routers configured as repeaters, shall comply with requirements of CEA-709.1-C and include connection between two or more CEA-709.3 TP/FT-10 channels or between two or more CEA-709.3 TP/FT-10 channels and a TP/XF-1250 channel.
- 2. IP Routers:
  - a. Perform layer three routing of CEA-709.1-C packets over an IP network according to CEA-852-B.
  - b. Include appropriate connection to the IP network and connections to CEA-709.3 TP/FT-10 or TP/XF-1250 network.
  - c. Support the Dynamic Host Configuration Protocol for IP configuration and use of an CEA-852-B Configuration Server (for CEA-852-B configuration), but shall not rely on these services for configuration.
  - d. Capable of manual configuration via a console RS-232 port.

### B. Gateways:

- 1. Perform bidirectional protocol translation from one non-CEA-709.1-C protocol to CEA-709.1-C.
- 2. Incorporate a network connection to a TP/FT-10 network according to CEA-709.3 and a connection for a non-CEA-709.1-C network.

## 2.17 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
  - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
  - 2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
  - 3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F.
- F. Power and Noise Immunity:
  - 1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
  - 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.
- G. DDC Controller Spare Processing Capacity:
  - 1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
    - a. Network Controllers: 50 percent.
    - b. Programmable Application Controllers: Not less than 60 percent.
    - c. Application-Specific Controllers: Not less than 70 percent.
  - 2. Memory shall support DDC controller's operating system and database and shall include the following:
    - a. Monitoring and control.
    - b. Energy management, operation and optimization applications.
    - c. Alarm management.
    - d. Historical trend data of all connected I/O points.
    - e. Maintenance applications.
    - f. Operator interfaces.
    - g. Monitoring of manual overrides.
- H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
  - 1. Network Controllers:

- a. 10 percent of each AI, AO, BI, and BO point connected to controller.
  - b. Minimum Spare I/O Points per Controller:
    - 1) AIs: Two .
    - 2) AOs: Two .
    - 3) BIs: Three .
    - 4) BOs: Three .
2. Programmable Application Controllers:
- a. 10 percent of each AI, AO, BI, and BO point connected to controller.
  - b. Minimum Spare I/O Points per Controller:
    - 1) AIs: Two .
    - 2) AOs: Two .
    - 3) BIs: Three .
    - 4) BOs: Three .
3. Application-Specific Controllers:
- a. 10 percent of each AI, AO, BI, and BO point connected to controller.
  - b. Minimum Spare I/O Points per Controller:
    - 1) AIs: One .
    - 2) AOs: One .
    - 3) BIs: One .
    - 4) BOs: One .
- I. Maintenance and Support: Include the following features to facilitate maintenance and support:
1. Mount microprocessor components on circuit cards for ease of removal and replacement.
  2. Means to quickly and easily disconnect controller from network.
  3. Means to quickly and easily access connect to field test equipment.
  4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.
- J. General Requirements for CEA-709.1-C DDC Controllers:
1. Controllers shall be LonMark certified.
  2. Distinguishable and accessible switch, button, or pin, when pressed shall broadcast its 48-bit Node ID and Program ID over network.
  3. TP/FT-10 transceiver according to CEA-709.3 and connections for TP/FT-10 control network wiring.
  4. TP/XF-1250 transceiver according to CEA-709.3 and connections for TP/XF-1250 control network wiring.
  5. Communicate using CEA-709.1-C protocol.
  6. Controllers configured into subnets, as required, to comply with performance requirements indicated.
  7. Network communication through LNS network management and database standard for CEA-709.1-C network devices.
  8. Locally powered, not powered through network connection.

9. Functionality required to support applications indicated, including, but not limited to, the following:
  - a. Input and outputs indicated and as required to support sequence of operation and application in which it is used. SNVTs shall have meaningful names identifying the value represented by an SNVT. Unless an SNVT of an appropriate engineering type is unavailable, all network variables shall be of an SNVT with engineering units appropriate to value the variable represents.
  - b. Configurable through SCPTs defined in LonMark SCPT List, operator-defined UCPTs, network configuration inputs (NCIs) of an SNVT type defined in LonMark SNVT List, NCIs of an operator-defined network variable type, or hardware settings on controller itself for all settings and parameters used by application in which it is used.
10. Programmable controllers shall conform to LonMark Interoperability Guidelines and have LonMark certification.

K. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:
  - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
  - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
  - c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of bits or better to comply with accuracy requirements indicated.
  - d. Signal conditioning including transient rejection shall be provided for each AI.
  - e. Capable of being individually calibrated for zero and span.
  - f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
5. AOs:
  - a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of bits or better to comply with accuracy requirements indicated.
  - b. Output signals shall have a range of as required to include proper control of output device.
  - c. Capable of being individually calibrated for zero and span.
  - d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
6. BIs:



- a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
  - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
  - c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
  - d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
  - e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
7. BOs:
- a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
    - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
    - 2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.
  - b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
  - c. BOs shall be selectable for either normally open or normally closed operation.
  - d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.
  - e. Limit use of three-point floating devices to VAV terminal unit control applications, and other applications indicated on Drawings,. Control algorithms shall operate actuator to one end of its stroke once every 24 hours for verification of operator tracking.

## 2.18 NETWORK CONTROLLERS

### A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers shall have a real-time clock.

7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system Level one network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

## 2.19 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.
2. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
3. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
4. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

## 2.20 APPLICATION-SPECIFIC CONTROLLERS

- A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
  1. Capable of standalone operation and shall continue to include control functions without being connected to network.
  2. Data shall be shared between networked controllers and other network devices.
- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.
- C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation.
- D. Serviceability:
  1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
  2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

## 2.21 CONTROLLER SOFTWARE

- A. General Controller Software Requirements:
  1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
  2. I/O points shall be identified by up to 30 -character point name and up to 16 -character point descriptor. Same names shall be used at operator workstations.
  3. Control functions shall be executed within controllers using DDC algorithms.
  4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

- B. Security:
  - 1. Operator access shall be secured using individual security passwords and user names.
  - 2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
  - 3. Operator log-on and log-off attempts shall be recorded.
  - 4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.
  
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
  - 1. Weekly Schedule:
    - a. Include separate schedules for each day of week.
    - b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
    - c. Each schedule may consist of up to 10 events.
    - d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
  
  - 2. Exception Schedules:
    - a. Include ability for operator to designate any day of the year as an exception schedule.
    - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
  
  - 3. Holiday Schedules:
    - a. Include capability for operator to define up to 99 special or holiday schedules.
    - b. Schedules may be placed on scheduling calendar and will be repeated each year.
    - c. Operator shall be able to define length of each holiday period.
  
- D. System Coordination:
  - 1. Include standard application for proper coordination of equipment.
  - 2. Application shall include operator with a method of grouping together equipment based on function and location.
  - 3. Group may then be used for scheduling and other applications.
  
- E. Binary Alarms:
  - 1. Each binary point shall be set to alarm based on operator-specified state.
  - 2. Include capability to automatically and manually disable alarming.
  
- F. Analog Alarms:
  - 1. Each analog object shall have both high and low alarm limits.
  - 2. Alarming shall be able to be automatically and manually disabled.

G. Alarm Reporting:

1. Operator shall be able to determine action to be taken in event of an alarm.
2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

H. Remote Communication:

1. System shall have ability to dial out in the event of an alarm.

I. Electric Power Demand Limiting:

1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
3. Demand reduction shall be accomplished by the following means:
  - a. Reset air-handling unit supply temperature set points.
  - b. Reset space temperature set points.
  - c. De-energize equipment based on priority.
4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:
  - a. Addition and deletion of loads controlled.
  - b. Changes in demand intervals.
  - c. Changes in demand limit for meter(s).
  - d. Maximum shutoff time for equipment.
  - e. Minimum shutoff time for equipment.
  - f. Select rotational or sequential shedding and restoring.
  - g. Shed and restore priority.
7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:
  - a. Total electric consumption.
  - b. Peak demand.
  - c. Date and time of peak demand.
  - d. Daily peak demand.

- J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.
- K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.
- L. Control Loops:
  - 1. Support any of the following control loops, as applicable to control required:
    - a. Two-position (on/off, open/close, slow/fast) control.
    - b. Proportional control.
    - c. Proportional plus integral (PI) control.
    - d. Proportional plus integral plus derivative (PID) control.
      - 1) Include PID algorithms with direct or reverse action and anti-windup.
      - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
      - 3) Controlled variable, set point, and PID gains shall be operator-selectable.
    - e. Adaptive (automatic tuning).
- M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.
- N. Energy Calculations:
  - 1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
  - 2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
  - 3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.
- O. Anti-Short Cycling:
  - 1. BO points shall be protected from short cycling.
  - 2. Feature shall allow minimum on-time and off-time to be selected.
- P. On and Off Control with Differential:
  - 1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
  - 2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.
- Q. Run-Time Totalization:
  - 1. Include software to totalize run-times for all BI points.

2. A high run-time alarm shall be assigned, if required, by operator.

## 2.22 ENCLOSURES

### A. General Enclosure Requirements:

1. House each controller and associated control accessories in a enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
6. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.

### B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch-high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least percent spare area on face of panel.

### C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
  2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
  3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
  4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
- D. Wall-Mounted, NEMA 250, Type 1:
1. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
  2. Construct enclosure of steel, not less than:
    - a. Enclosure size less than 24 in.: 0.053 in. thick.
    - b. Enclosure size 24 in. and larger: 0.067 in. thick.
  3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
    - a. Exterior color shall be manufacturer's standard.
    - b. Interior color shall be manufacturer's standard.
  4. Hinged door full size of front face of enclosure and supported using:
    - a. Enclosures sizes less than 36 in. tall: Multiple butt hinges.
    - b. Enclosures sizes 36 in. tall and larger: Continuous piano hinges.
  5. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
    - a. Size less than 24 in.: Solid or Perforated steel, 0.053 in. thick.
    - b. Size 24 in. and larger: Solid aluminum, 0.10 in. thick.
  6. Internal panel mounting hardware, grounding hardware and sealing washers.
  7. Grounding stud on enclosure body.
  8. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- E. Wall Mounted NEMA 250, Types 4 and 12:
1. Enclosure shall be NRTL listed according to UL 508A.
  2. Seam and joints are continuously welded and ground smooth.
  3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
  4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
  5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
  6. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
  7. Construct enclosure of steel, not less than the following:



- a. Size Less Than 24 Inches: 0.053 inch thick.
  - b. Size 24 Inches and Larger: 0.067 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
- a. Exterior color shall be manufacturer's standard.
  - b. Interior color shall be manufacturer's standard.
9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
- a. Sizes through 24 Inches Tall: Two hinges.
  - b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
  - c. Sizes Larger 48 Inches Tall: Four hinges.
10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
- a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.
11. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
- a. Size Less Than 24 Inches: steel, 0.053 inch thick.
  - b. Size 24 Inches and Larger: Solid thick.
12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.
14. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- F. Accessories:
1. Electric Heater:
    - a. Aluminum housing with brushed finish.
    - b. Thermostatic control with adjustable set point from zero to 100 deg F.
    - c. Capacity: 100, 200, 400, and 800 W as required by application.
    - d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.
  2. Ventilation Fans, Filtered Intake and Exhaust Grilles:
    - a. Number and size of fans, filters and grilles as required by application.
    - b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
    - c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
    - d. Thermostatic control with adjustable set point from 32 to 140 deg F.

- e. Airflow Capacity at Zero Pressure:
    - 1) 4-Inch Fan: 100 cfm.
    - 2) 6-Inch Fan: 240 cfm.
    - 3) 10-Inch Fan: 560 cfm.
  - f. Maximum operating temperature of 158 deg F.
  - g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
  - h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
  - i. Dynamically balanced impellers molded from polycarbonate material.
  - j. Fan furnished with power cord and polarized plug for power connection.
  - k. Fan brackets, finger guards and mounting hardware provided with fans to complete installation.
  - l. Removable Intake and Exhaust Grilles: of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
  - m. Filters for NEMA 250, Type 1 Enclosures: Washable , of a size to match intake grille.
  - n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of a size to match intake grille.
- 3. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:
    - a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
    - b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
    - c. Window kit shall be factory or shop installed before shipment to Project.
  - 4. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:
    - a. 0.125-inch-thick, polycarbonate window mounted in enclosure door material.
    - b. Window attached to door with screw fasteners and continuous strip of high-strength double-sided tape around window perimeter.
    - c. Window kit shall be factory or shop installed before shipment to Project.
  - 5. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:
    - a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
    - b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
    - c. Window kit shall be factory or shop installed before shipment to Project.
  - 6. Bar handle with keyed cylinder lock set.

## 2.23 RELAYS

### A. General-Purpose Relays:

1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Performance:
  - a. Mechanical Life: At least 10 million cycles.
  - b. Electrical Life: At least 100,000 cycles at rated load.
  - c. Pickup Time: 15 ms or less.
  - d. Dropout Time: 10 ms or less.
  - e. Pull-in Voltage: 85 percent of rated voltage.
  - f. Dropout Voltage: 50 percent of nominal rated voltage.
  - g. Power Consumption: 2 VA.
  - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a dust-tight cover.
6. Include knob and dial scale for setting delay time.
7. Performance:
  - a. Mechanical Life: At least 10 million cycles.
  - b. Electrical Life: At least 100,000 cycles at rated load.
  - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
  - d. Repeatability: Within 2 percent.
  - e. Recycle Time: 45 ms.
  - f. Minimum Pulse Width Control: 50 ms.
  - g. Power Consumption: 5 VA or less at 120-V ac.
  - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
  2. Relays shall be either DPDT or three-pole double throw, depending on the control application.
  3. Use a plug-in-style relay with a multibladed plug.
  4. Construct the contacts of either silver cadmium oxide or gold.
  5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
  6. Performance:
    - a. Mechanical Life: At least 10 million cycles.
    - b. Electrical Life: At least 100,000 cycles at rated load.
    - c. Pickup Time: 15 ms or less.
    - d. Dropout Time: 10 ms or less.
    - e. Pull-in Voltage: 85 percent of rated voltage.
    - f. Dropout Voltage: 50 percent of nominal rated voltage.
    - g. Power Consumption: 2 VA.
    - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
  7. Equip relays with coil transient suppression to limit transients to non-damaging levels.
  8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
  9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.
- D. Current Sensing Relay:
1. Monitors ac current.
  2. Independent adjustable controls for pickup and dropout current.
  3. Energized when supply voltage is present and current is above pickup setting.
  4. De-energizes when monitored current is below dropout current.
  5. Dropout current is adjustable from 50 to 95 percent of pickup current.
  6. Include a current transformer, if required for application.
  7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.
- E. Combination On-Off Status Sensor and On-Off Relay:
1. Description:
    - a. On-off control and status indication in a single device.
    - b. LED status indication of activated relay and current trigger.
    - c. Closed-Open-Auto override switch located on the load side of the relay.
  2. Performance:
    - a. Ambient Temperature: Minus 30 to 140 deg F.
    - b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
  3. Status Indication:
    - a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
    - b. Current Sensor Range: As required by application.

- c. Current Set Point: .
- d. Current Sensor Output:
  - 1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
  - 2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
  - 3) Analog, zero- to 5- or 10-V dc.
  - 4) Analog, 4 to 20 mA, loop powered.
- 4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
- 5. Enclosure: NEMA 250, Type 1 enclosure.

## 2.24 ELECTRICAL POWER DEVICES

### A. Transformers:

- 1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
- 2. Transformer shall be at least 40 VA.
- 3. Transformer shall have both primary and secondary fuses.

### B. DC Power Supply:

- 1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
- 2. Enclose circuitry in a housing.
- 3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
- 4. Performance:
  - a. Output voltage nominally 25-V dc within 5 percent.
  - b. Output current up to 100 mA.
  - c. Input voltage nominally 120-V ac, 60 Hz.
  - d. Load regulation within 0.5 percent from zero- to 100-mA load.
  - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
  - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

## 2.25 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

### A. 250 through 1000 VA:

- 1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
- 2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
  - a. Larger-capacity units shall be provided for systems with larger connected loads.
  - b. UPS shall provide five minutes of battery power.
- 3. Performance:

- a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
  - b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
  - c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
  - d. On Battery Output Voltage: Sine wave.
  - e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
  - f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
  - g. Transfer Time: 6 ms.
  - h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.
4. UPS shall be automatic during fault or overload conditions.
  5. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
  6. Include front panel with power switch and visual indication of power, battery, fault and temperature.
  7. Unit shall include an audible alarm of faults and front panel silence feature.
  8. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
  9. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure).
  10. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
  11. Include tower models installed in ventilated cabinets to the particular installation location.
- B. 1000 through 3000 VA:
1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
  2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
    - a. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.
    - b. UPS shall provide five minutes of battery power.
  3. Performance:
    - a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.
    - b. Power Factor: Minimum 0.97 at full load.
    - c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
    - d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
    - e. Recharge time shall be a maximum of eight hours to 90 percent capacity.
  4. UPS bypass shall be automatic during fault or overload conditions.
  5. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure).
  6. Batteries shall be sealed lead-acid type and be maintenance free.

7. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

## 2.26 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
  1. Wire size shall be at least No. 18 AWG.
  2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
  3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
  4. Conductor colors shall be black (hot), white (neutral), and green (ground).
  5. Furnish wire on spools.
- B. Single Twisted Shielded Instrumentation Cable above 24 V:
  1. Wire size shall be a minimum No. 18 AWG.
  2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
  3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
  4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
  5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
  6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
  7. Furnish wire on spools.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
  1. Wire size shall be a minimum No. 18 AWG.
  2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
  3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
  4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
  5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
  6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
  7. Furnish wire on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
  1. Cable shall be plenum rated.
  2. Cable shall comply with NFPA 70.
  3. Cable shall have a unique color that is different from other cables used on Project.
  4. Copper Cable for Ethernet Network:

- a. 100BASE-TX 1000BASE-T or 1000BASE-TX.
- b. TIA/EIA 586, Category 5e or Category 6.
- c. Minimum No. 24 AWG solid.
- d. Shielded Twisted Pair (STP).
- e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

## 2.27 RACEWAYS FOR CONTROL WIRING, CABLING, AND TUBING

### A. Metal Conduits, Tubing, and Fittings:

1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. GRC: Comply with NEMA ANSI C80.1 and UL 6.
  3. ARC: Comply with NEMA ANSI C80.5 and UL 6A.
  4. IMC: Comply with NEMA ANSI C80.6 and UL 1242.
  5. PVC-Coated Steel Conduit: PVC-coated .
    - a. Comply with NEMA RN 1.
    - b. Coating Thickness: 0.040 inch, minimum.
  6. EMT: Comply with NEMA ANSI C80.3 and UL 797.
  7. FMC: Comply with UL 1; zinc-coated steel .
  8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
  9. Fittings for Metal Conduit: Comply with NEMA ANSI FB 1 and UL 514B.
    - a. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
    - b. Fittings for EMT:
      - 1) Material: Steel or die cast.
      - 2) Type: Setscrew or compression.
    - c. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
    - d. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
  10. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
- ### B. Metal Wireways and Auxiliary Gutters:
1. Description: Sheet metal, complying with UL 870 and NEMA 250, unless otherwise indicated, and sized according to NFPA 70.



- a. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
  3. Wireway Covers: Hinged type unless otherwise indicated.
  4. Finish: Manufacturer's standard enamel finish.
- C. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5..

## 2.28 CONTROL POWER WIRING AND RACEWAYS

- A. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" electrical power conductors and cables.
- B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

## 2.29 ACCESSORIES

- A. Damper Blade Limit Switches:
  1. Sense positive open and/or closed position of the damper blades.
  2. NEMA 250, Type 13, oil-tight construction.
  3. Arrange for the mounting application.
  4. Additional waterproof enclosure when required by its environment.
  5. Arrange to prevent "over-center" operation.
- B. Manual Valves:
  1. Needle Type:
    - a. PTFE packing.
    - b. Construct of brass for use with copper and polyethylene tubing and of stainless steel for use with stainless-steel tubing.
    - c. Aluminum T-bar handle.
    - d. Include tubing connections.
  2. Ball Type:
    - a. Body: Bronze ASTM B 62 or ASTM B 61.
    - b. Ball: Type 316 stainless steel.
    - c. Stem: Type 316 stainless steel.
    - d. Seats: Reinforced PTFE.
    - e. Packing Ring: Reinforced PTFE.
    - f. Lever: Stainless steel with a vinyl grip.
    - g. 600 WOG.
    - h. Threaded end connections.

## 2.30 IDENTIFICATION

### A. Control Equipment, Instruments, and Control Devices:

1. Engraved tag bearing unique identification.
  - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Letter size shall be as follows:
  - a. Operator Workstations: Minimum of 0.5 inch high.
  - b. Printers: Minimum of 0.5 inch high.
  - c. DDC Controllers: Minimum of 0.5 inch high.
  - d. Gateways: Minimum of 0.5 inch high.
  - e. Repeaters: Minimum of 0.5 inch high.
  - f. Enclosures: Minimum of 0.5 inch high.
  - g. Electrical Power Devices: Minimum of 0.25 inch high.
  - h. UPS units: Minimum of 0.5 inch high.
  - i. Accessories: Minimum of 0.25 inch high.
  - j. Instruments: Minimum of 0.25 inch high.
  - k. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
3. Tag shall consist of white lettering on black background.
4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.
5. Tag shall be fastened with drive pins.
6. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

### B. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tags shall be at least  $\frac{1}{2}$  inch in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

### C. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.

3. For raceways housing pneumatic tubing, add a phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."

D. Equipment Warning Labels:

1. Acrylic label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch beyond white border.

2.31 SOURCE QUALITY CONTROL

- A. Product(s) will be considered defective if not pass tests and inspections.
- B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
  1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
  2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:

1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
2. Equipment to Be Connected:
  - a. Domestic water booster pumps specified in Section 221123.13 "Domestic-Water Packaged Booster Pumps."
  - b. Air-terminal units specified in Section 233600 "Air Terminal Units."
  - c. Kitchen hoods specified in Section 233813 "Commercial-Kitchen Hoods."
  - d. Boilers specified in Section 235213 "Electric Boilers."
  - e. Boilers specified in Section 235216 "Condensing Boilers."
  - f. Boilers specified in Section 235223 "Cast-Iron Boilers."
  - g. Boilers specified in Section 235233 "Water-Tube Boilers."
  - h. Boilers specified in Section 235239 "Fire-Tube Boilers."
  - i. Feedwater equipment specified in Section 235313 "Boiler Feedwater Pumps."
  - j. Deaerators specified in Section 235316 "Deaerators."
  - k. Chillers specified in Section 236413.13 "Direct-Fired Absorption Water Chillers."
  - l. Chillers specified in Section 236413.16 "Indirect-Fired Absorption Water Chillers."
  - m. Chillers specified in Section 236416 "Centrifugal Water Chillers."
  - n. Chillers specified in Section 236419 "Reciprocating Water Chillers."
  - o. Chillers specified in Section 236423 "Scroll Water Chillers."
  - p. Chillers specified in Section 236426 "Rotary-Screw Water Chillers."
  - q. Cooling towers specified in Section 236500 "Cooling Towers."
  - r. Heat wheels and heat exchangers specified in Section 237200 "Air-to-Air Energy Recovery Equipment."
  - s. Air-handling units specified in Section 237313 "Modular Indoor Central-Station Air-Handling Units."
  - t. Roof-top units specified in Section 237413 "Packaged, Outdoor, Central-Station Air-Handling Units."
  - u. Dedicated outdoor-air units specified in Section 237433 "Dedicated Outdoor-Air Units."
  - v. Packaged terminal air-conditioners specified in Section 238113.11 "Packaged Terminal Air-Conditioners, Through-Wall Units," Section 238113.12 "Packaged Terminal Air-Conditioners, Freestanding Units, " and Section 238113.13 "Packaged Terminal Air-Conditioners, Outdoor, Wall-Mounted Units."
  - w. Computer-room air-conditioning units specified in Section 238123.11 "Computer-Room Air Conditioners, Floor-Mounted Units (6 Tons (21 kW) And Smaller)," Section 238123.12 "Computer-Room Air Conditioners, Floor-Mounted Units (7 Tons (25 kW) And Larger)," Section 238123.13 "Computer-Room Air Conditioners, Ceiling-Mounted Units," Section 238123.14 "Computer-Room Air Conditioners, Console Units," Section 238123.18 "Computer-Room, Rack-Cooling Equipment."
  - x. Fan-coil units specified in Section 238219 "Fan Coil Units."
  - y. Unit ventilators specified in Section 238223 "Unit Ventilators."
  - z. Humidifiers specified in Section 238413 "Humidifiers."
  - aa. Dehumidification units specified in Section 238416 "Mechanical Dehumidification Units."
  - bb. Switchboards specified in Section 262300 "Low-Voltage Switchgear."
  - cc. Motor-control centers specified in Section 262419 "Motor-Control Centers."
  - dd. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Motor Controllers."

- ee. Generator sets specified in Section 263213 "Engine Generators."
- ff. UPS specified in Section 263353 "Static Uninterruptible Power Supply."
- gg. Refrigerant monitoring.

B. Communication Interface to Other Building Systems:

1. DDC system shall have a communication interface with systems having a communication interface.
2. Systems to Be Connected:
  - a. Elevators specified in Section 142100 "Electric Traction Elevators."
  - b. Elevators specified in Section 142113 "Electric Traction Freight Elevators."
  - c. Elevators specified in Section 142400 "Hydraulic Elevators."
  - d. Elevators specified in Section 142413 "Hydraulic Freight Elevators."
  - e. Escalators specified in Section 143100 "Escalators."
  - f. Automated water treatment systems specified in Section 232500 "HVAC Water Treatment."
  - g. Automated water treatment systems specified in Section 232516 "Water Treatment for Open-Loop Hydronic Systems."
  - h. Automated water treatment systems specified in Section 232519 "Water Treatment for Steam System Feedwater."
  - i. Power monitoring specified in Section 260913 "Electrical Power Monitoring and Control."
  - j. Lighting controls specified in Section 260926 "Lighting Control Panelboards."
  - k. Lighting controls specified in Section 260943.16 "Addressable-Fixture Lighting Controls."
  - l. Lighting controls specified in Section 260943.23 "Relay-Based Lighting Controls."
  - m. Fire-alarm system specified in Section 283111 "Digital, Addressable Fire Alarm System."
  - n. Fire-alarm system specified in Section 283112 "Zoned (DC Loop) Fire-Alarm System."
  - o. Access controls specified in Section 281300 "Access Control."
  - p. Intrusion detection specified in Section 281600 "Intrusion Detection."
  - q. Perimeter security specified in Section 281643 "Perimeter Security Systems."

3.3 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
  1. DDC control dampers, which are specified in Section 230923.12 "DDC Control Dampers."
  2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
  3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."

- C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
  - 1. DDC control valves, which are specified in Section 230923.11 "Control Valves."
  - 2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
  - 3. Pipe-mounted sensors, switches and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments." Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
  - 4. Tank-mounted sensors, switches and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments." Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
  - 5. Pipe- and tank-mounted thermowells. Liquid thermowells are specified in Section 230923.27 "Temperature Instruments."

### 3.4 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

- A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer.
  - 1. Programmable application or application-specific controller.
  - 2. Unit-mounted DDC control dampers and actuators, which are specified in Section 230923.12 "Control Dampers."
  - 3. Unit-mounted airflow sensors, switches and transmitters, which are specified in Section 230923.14 "Flow Instruments."
  - 4. Unit-mounted gas sensors and transmitters, which are specified in Section 230923.16 "Gas Instruments."
  - 5. Unit-mounted leak-detection switches, which are specified in Section 230923.18 "Leak-Detection Instruments."
  - 6. Unit-mounted speed sensors, switches and transmitters, which are specified in Section 230923.24 "DDC Speed Instruments."
  - 7. Unit-mounted pressure sensors, switches and transmitters, which are specified in Section 230923.23 "Pressure Instruments."
  - 8. Unit-mounted temperature sensors, switches and transmitters. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
  - 9. Relays.
- B. Deliver the following to fan-coil unit manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.
  - 1. controller.
  - 2. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
  - 3. Flow and pressure switches. Air and liquid flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
  - 4. Leak-detection switches, which are specified in Section 230923.18 "Leak-Detection Instruments."
  - 5. Relays.

### 3.5 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop penetrations made in fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."
- H. Welding Requirements:
  - 1. Restrict welding and burning to supports and bracing.
  - 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
  - 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
  - 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.
- K. Corrosive Environments:
  - 1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:
    - a. Laboratory exhaust-air streams.
    - b. Process exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.6 OPERATOR WORKSTATION INSTALLATION

#### A. Desktop Operator Workstations Installation:

1. Install operator workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
3. Install software on workstation(s) and verify software functions properly.
4. Develop Project-specific graphics, trends, reports, logs and historical database.
5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.

#### B. Portable Operator Workstations Installation:

1. Turn over portable operator workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify software functions properly.

#### C. Color Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

### 3.7 POT INSTALLATION

- A. Install portable operator terminal(s).
- B. Turn over POTs to Owner at Substantial Completion.
- C. Install software on each POT and verify that software functions properly.



### 3.8 PRINTER INSTALLATION

- A. Provide the following printer(s) at location(s) directed by Owner:
  - 1. Color Inkjet: Quantity,.
  - 2. Dot Matrix: Quantity,.
- B. Install printer software on workstations and verify that software functions properly.

### 3.9 GATEWAY INSTALLATION

- A. Install gateways if required for DDC system communication interface requirements indicated.
  - 1. Install gateway(s) required to suit indicated requirements.
- B. Test gateway to verify that communication interface functions properly.

### 3.10 ROUTER INSTALLATION

- A. Install routers if required for DDC system communication interface requirements indicated.
  - 1. Install router(s) required to suit indicated requirements.
- B. Test router to verify that communication interface functions properly.

### 3.11 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply and to UPS units where indicated.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
  - 1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  - 2. Install controllers in a protected location that is easily accessible by operators.
  - 3. Top of controller shall be within 72 inches of finished floor.
- F. Installation of Programmable Application Controllers:
  - 1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  - 2. Install controllers in a protected location that is easily accessible by operators.

3. Top of controller shall be within of finished floor.

G. Application-Specific Controllers:

1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

### 3.12 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.
8. Instruments.
9. Actuators

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250, Type 1 Enclosures: Use corrosion-resistant-coated steel strut and hardware.
2. For NEMA 250, Type 4X Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top or bottom of adjacent enclosures.

D. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

### 3.13 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.
- E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

### 3.14 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.
- B. Install engraved phenolic nameplate with unique identification on face for each of the following:
  - 1. Operator workstation.
  - 2. Printer.
  - 3. Gateway.
  - 4. Router.
  - 5. DDC controller.
  - 6. Enclosure.
  - 7. Electrical power device.
  - 8. UPS unit.
  - 9. Accessory.
- C. Install engraved phenolic nameplate with unique instrument identification on face of each instrument connected to a DDC controller.
- D. Install engraved phenolic nameplate with identification on face of each control actuator connected to a DDC controller.
- E. Where product is installed above accessible tile ceiling, also install matching engraved phenolic nameplate with identification on face of ceiling grid located directly below.
- F. Where product is installed above an inaccessible ceiling, also install engraved phenolic nameplate with identification on face of access door directly below.
- G. Warning Labels:
  - 1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
  - 2. Shall be located in highly visible location near power service entry points.

### 3.15 NETWORK INSTALLATION

- A. Install copper cable when connecting between the following network devices:
  - 1. Operator workstations.
  - 2. Operator workstations and network controllers.

3. Network controllers.
- B. Install copper cable when connecting between the following:
1. Gateways.
  2. Gateways and network controllers or programmable application controllers.
  3. Routers.
  4. Routers and network controllers or programmable application controllers.
  5. Network controllers and programmable application controllers.
  6. Programmable application controllers.
  7. Programmable application controllers and application-specific controllers.
  8. Application-specific controllers.
- C. Install network cable in continuous raceway.
1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

### 3.16 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.
- B. ASHRAE 135 Networks:
1. MAC Address:
    - a. Every network device shall have an assigned and documented MAC address unique to its network.
    - b. Ethernet Networks: Document MAC address assigned at its creation.
    - c. ARCNET or MS/TP networks: Assign from 00 to 64.
  2. Network Numbering:
    - a. Assign unique numbers to each new network.
    - b. Provide ability for changing network number through device switches or operator interface.
    - c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
  3. Device Object Identifier Property Number:
    - a. Assign unique device object identifier property numbers or device instances for each device network.
    - b. Provide for future modification of device instance number by device switches or operator interface.
    - c. LAN shall support up to 4,194,302 unique devices.
  4. Device Object Name Property Text:
    - a. Device object name property field shall support 32 minimum printable characters.

- b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
  - 1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
  - 2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
- 5. Object Name Property Text for Other Than Device Objects:
  - a. Object name property field shall support 32 minimum printable characters.
  - b. Assign object name properties with plain-English names descriptive of application.
    - 1) Example 1: "Zone 1 Temperature."
    - 2) Example 2 "Fan Start and Stop."
- 6. Object Identifier Property Number for Other Than Device Objects:
  - a. Assign object identifier property numbers according to indicated.
  - b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

### 3.17 PIPING AND TUBING INSTALLATION

#### A. Above-Grade Pneumatic and Air Signal Piping and Tubing Installation:

- 1. Material Application:
  - a. Install copper tubing, except as follows:
    - 1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
    - 2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when concealed behind accessible ceilings .
  - b. Install copper tubing, unless other accessible materials are indicated, for air signals to instruments including, but not limited to, the following:
    - 1) Sensors.
    - 2) Switches.
    - 3) Transmitters.
  - c. Install drawn-temper copper tubing, except within 36 inches of device terminations tubing shall be annealed-tempered copper tubing.
  - d. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
  - e. Install fittings to connect polyethylene tubing to instruments, control devices, and accessories.

2. Routing:
  - a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
  - b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling or behind architectural enclosures or covers.
  - c. Install piping and tubing plumb and parallel to and at right angles with building construction.
  - d. Install multiple runs of tubing or piping in equally spaced parallel lines.
  - e. Piping and tubing shall not interfere with access to valves, equipment, duct and equipment access doors, or obstruct personnel access and passageways of any kind.
  - f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on record Drawings.
  - g. Install vibration loops in copper tubing when connecting to instrument and actuators that vibrate.
3. Support:
  - a. According to MSS SP-69, Table 3, except support spacing shall not exceed 60 inches.
  - b. Support copper tubing with copper hangers, clips, and tube trays.
  - c. Do not use tape for support or dielectric isolation.
  - d. Install supports at each change in direction and at each branch take off.
  - e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
  - f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
  - g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
  - h. Brace supports to prevent lateral movement.
  - i. Paint steel support members that are not galvanized or zinc coated.
  - j. Support polyethylene tubing same as copper tubing.
4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
5. Protect exposed tubing in mechanical equipment rooms from mechanical damage within 76 inches above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
6. Joining and Makeup:
  - a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
  - b. Install a dirt leg with an isolation valve and threaded plug at each main air, connection to a panel, pneumatic pilot positioner and PRV station.
  - c. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on other end.

- d. Make tubing bends with a tube-bending tool. Hard bends, wrinkled or flattened bends are unacceptable.
  - e. Install tube fittings according to manufacturer's written instructions.
  - f. Do not make tubing connections to a fitting before completing makeup of the connection.
  - g. Align tubing with the fitting. Avoid springing tube into position, as this may result in excessive stress on both tubing and fitting with possible resulting leaks.
  - h. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
  - i. Check tubing for correct diameter and wall thickness.
  - j. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.
  - k. Thread pipe on a threading machine. Ream inner edges of pipe ends, file and grind to remove burrs.
  - l. Wrap pipe threads of fittings on pneumatic lines with a single wrap of PTFE tape.
  - m. Protect piping and tubing from entrance of foreign matter.
7. Conduit in which nonmetallic tubing is installed shall not exceed 50 percent fill. Support conduit according to NFPA 70 unless otherwise indicated.
- B. Identify piping and tubing as follows:
1. Every 50 feet of straight run.
  2. At least once for each branch within 36 inches of main tee.
  3. At each change in direction.
  4. Within 36 inches of each ceiling, floor, roof and wall penetration.
  5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
  6. At each valve.
  7. Mark each instrument tube connection with a number-coded identification. Each unique tube shall have same unique number at instrument connection and termination at opposite end of tube.
- C. Isolation Valves Installation:
1. Install valves full size of piping and tubing.
  2. Install at the following locations:
    - a. At each branch.
    - b. Before and after each PRV.
    - c. Before and after each air dryer.
    - d. At each control device.
  3. Valves shall be located to be readily accessible from floor.
- D. Process Tubing Installation:
1. Install process tubing for signal to instruments in liquid and steam systems. Instruments include, but are not limited to, the following:
    - a. Meters.

- b. Sensors.
  - c. Switches.
  - d. Transmitters.
2. Support tubing according to MSS SP-69, Table 3, but at intervals no less than 60 inches.
  3. Install NPS 1/2 process tubing for industrial-grade sensors, transmitters, and switches. Install stainless-steel bushings where required.
  4. Make tubing bends with a bending tool. Flattened or wrinkled bends are unacceptable.
  5. Support tubing independent of other trades.
  6. Route tubing parallel to and at right angles to building construction.
  7. Install tubing concealed in areas with ceilings.
  8. Install a dirt leg with an isolation valve and threaded plug in drain valve at each connection to a transmitter and switch.
  9. Insulate process piping connected to hot water and steam systems for personnel protection if the surface temperature exceeds 120 deg F. Only insulate piping within maintenance personnel reach from floor, platform, or catwalk.
  10. Wrap pipe threads of fitting in process tubing with service temperatures below 350 deg F with a single wrap of PTFE tape.
  11. Coat pipe threads of fittings on process tubing in services with temperatures exceeding 350 deg F with pipe compound before being made up to reduce the possibility of galling.
  12. Do not make tubing connections to a fitting before completing makeup of the connection.
  13. Check tubing for correct diameter and wall thickness. Cut the tube ends square and deburred. Exercise care during cutting to keep tubing round.
  14. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
  15. Align tubing with fitting when installed. Avoid springing tube into position.
  16. Install tubing with extreme care exercised to keep foreign matter out of system. Open tubing ends shall be kept plugged to keep out dust, dirt and moisture.
  17. Do not attach tubing to equipment that may be removed frequently for maintenance or may impart vibration and expansion from temperature change.
  18. Protect exposed tubing in mechanical equipment rooms from inadvertent mechanical damage within 76 inches above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.

E. Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install isolation valves at the following locations:
  - a. Process connection.
  - b. Inlet to each instrument including, sensors, transmitters, switches, gages, and other control devices.
3. Locate valves to be readily accessible from floor.

3.18 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

- A. Comply with NECA 1.
- B. Comply with TIA 568-C.1.



- C. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
  - 3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- E. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Conduit Installation:
  - 1. Install conduit expansion joints where conduit runs exceed 200 feet, and conduit crosses building expansion joints.
  - 2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.
  - 3. Maintain at least 3-inch separation where conduits run axially above or below ducts and pipes.
  - 4. Limit above-grade conduit runs to 100 feet without pull or junction box.
  - 5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
  - 6. Do not fasten conduits onto the bottom side of a metal deck roof.
  - 7. Flexible conduit is permitted only where flexibility and vibration control is required.
  - 8. Limit flexible conduit to 3 feet long.
  - 9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
  - 10. Direct bury conduits underground or install in concrete-encased duct bank where indicated.
    - a. Use rigid, nonmetallic, Schedule 80 PVC.
    - b. Provide a burial depth according to NFPA 70, but not less than 24 inches.
  - 11. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
  - 12. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
  - 13. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
  - 14. Offset conduits where entering surface-mounted equipment.
  - 15. Seal conduit runs used by sealing fittings to prevent the circulation of air for the following:

- a. Conduit extending from interior to exterior of building.
- b. Conduit extending into pressurized duct and equipment.
- c. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

G. Wire and Cable Installation:

1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
  - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. UTP Cable Installation:
  - a. Comply with TIA 568-C.2.
  - b. Do not untwist UTP cables more than 1/2 inch from the point of termination, to maintain cable geometry.
6. Installation of Cable Routed Exposed under Raised Floors:
  - a. Install plenum-rated cable only.
  - b. Install cabling after the flooring system has been installed in raised floor areas.
  - c. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
7. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
8. Provide strain relief.
9. Terminate wiring in a junction box.
  - a. Clamp cable over jacket in junction box.
  - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
10. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
11. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
12. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

13. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
14. Wire and cable shall be continuous from terminal to terminal without splices.
15. Use insulated spade lugs for wire and cable connection to screw terminals.
16. Use shielded cable to transmitters.
17. Use shielded cable to temperature sensors.
18. Perform continuity and meager testing on wire and cable after installation.
19. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation, and replace it with new cable.
20. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
21. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
22. Protection from Electro-Magnetic Interference (EMI): Provide installation free of (EMI). As a minimum, comply with the following requirements:
  - a. Comply with BICSI TDMM and TIA 569-C for separating unshielded cable from potential EMI sources, including electrical power lines and equipment.
  - b. Separation between open cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
  - c. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
  - d. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
  - e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
  - f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.19 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.
- C. Perform the following tests and inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Testing of Pneumatic and Air-Signal Tubing:
    - a. Test for leaks and obstructions.
    - b. Disconnect each pipe and tubing line before a test is performed, and blowout dust, dirt, trash, condensate and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Air from an oil-free compressor with an air dryer is an acceptable alternative for the test.
    - c. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
    - d. Connect a pressure source to near end of run with a needle valve between air supply and tubing run.
    - e. Connect a pressure gage accurate to within 0.5 percent of test between the shutoff needle valve and tubing run under test.
    - f. For system pressures above 30 psig, apply a pressure of 1.5 times operating pressure. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 1 psig.
    - g. For system pressures 30 psig and below, apply a pressure of 2.0 times operating pressure to piping and tubing run. Record pressure in tubing run every 5 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 0.5 psig.
- D. Testing:
  - 1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
  - 2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
  - 3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
  - 4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
  - 5. Test Equipment: Use a fiber-optic time domain reflectometer for testing of length and optical connectivity.

6. Test Results: Record test results and submit copy of test results for Project record.

### 3.20 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
- E. For pneumatic products, verify that air supply for each product is properly installed.
- F. Control Damper Checkout:
  1. Verify that control dampers are installed correctly for flow direction.
  2. Verify that proper blade alignment, either parallel or opposed, has been provided.
  3. Verify that damper frame attachment is properly secured and sealed.
  4. Verify that damper actuator and linkage attachment is secure.
  5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
  6. Verify that damper blade travel is unobstructed.
- G. Control Valve Checkout:
  1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
  2. Verify that control valves are installed correctly for flow direction.
  3. Verify that valve body attachment is properly secured and sealed.
  4. Verify that valve actuator and linkage attachment is secure.
  5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
  6. Verify that valve ball, disc or plug travel is unobstructed.
  7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
- H. Instrument Checkout:
  1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
  2. Verify that attachment is properly secured and sealed.
  3. Verify that conduit connections are properly secured and sealed.
  4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
  5. Inspect instrument tag against approved submittal.
  6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.

7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:
  - a. Verify sensing element type and proper material.
  - b. Verify length and insertion.

3.21 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
  1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
  2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
  3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
  1. Check digital signals using a jumper wire.
  2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

### 3.22 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

### 3.23 DDC CONTROLLER I/O CONTROL LOOP TESTS

#### A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
  - a. Upper quarter of range.
  - b. Lower quarter of range.
  - c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

### 3.24 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
  1. Detailed explanation for any items that are not completed or verified.
  2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
  3. HVAC equipment motors operate below full-load amperage ratings.
  4. Required DDC system components, wiring, and accessories are installed.
  5. Installed DDC system architecture matches approved Drawings.
  6. Control electric power circuits operate at proper voltage and are free from faults.
  7. Required surge protection is installed.
  8. DDC system network communications function properly, including uploading and downloading programming changes.



9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power.
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power.
18. Meter, sensor and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
  - a. Verify analog I/O points at operating value.
  - b. Make adjustments to out-of-tolerance I/O points.
    - 1) Identify I/O points for future reference.
    - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
    - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:

- a. Re-check I/O points that required corrections during initial test.
  - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
- a. Re-check I/O points that required corrections during second test.
  - b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.
- G. DDC System Response Time Test:
1. Simulate HLC.
    - a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
  2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
  3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
  4. Purpose of test is to demonstrate DDC system, as follows:
    - a. Reaction to COV and alarm conditions during HLC.
    - b. Ability to update DDC system database during HLC.
  5. Passing test is contingent on the following:
    - a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
    - b. All alarms, both binary and analog, are reported and printed; none are lost.
    - c. Compliance with response times specified.
  6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.
- H. DDC System Network Bandwidth Test:
1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
  2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.25 FINAL REVIEW

- A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. Written request shall state the following:
  1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
  2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
  3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
  4. DDC system is complete and ready for final review.
- B. Review by Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.
  1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
  2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
  3. Demonstration shall include, but not be limited to, the following:
    - a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
    - b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    - d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.

- e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
- f. Trends, summaries, logs and reports set-up for Project.
- g. For up to HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
- h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
- i. Software's ability to edit control programs off-line.
- j. Data entry to show Project-specific customizing capability including parameter changes.
- k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
- l. Execution of digital and analog commands in graphic mode.
- m. Spreadsheet and curve plot software and its integration with database.
- n. Online user guide and help functions.
- o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
- p. System speed of response compared to requirements indicated.
- q. For Each Network and Programmable Application Controller:
  - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
  - 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable operator workstation and PDA. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
  - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
  - 4) Electric Power: Ability to disconnect any controller safely from its power source.
  - 5) Wiring Labels: Match control drawings.
  - 6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
  - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- r. For Each Operator Workstation:
  - 1) I/O points lists agree with naming conventions.
  - 2) Graphics are complete.
  - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Requirements must be met even if only one manufacturer's equipment is installed.

- 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
- 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
- 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
- 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
- 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
- 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
- 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
- 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
- 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
- 10) Device and Network Management:
  - a) Display of network device status.
  - b) Display of BACnet Object Information.
  - c) Silencing devices transmitting erroneous data.
  - d) Time synchronization.
  - e) Remote device re-initialization.
  - f) Backup and restore network device programming and master database(s).
  - g) Configuration management of routers.

### 3.26 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to visits to Project during other-than-normal occupancy hours for this purpose.

### 3.27 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include six months' full maintenance by DDC system manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

### 3.28 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year(s).
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

### 3.29 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
  - 1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
  - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
  - 3. Minimum Training Requirements:
    - a. Provide not less than days of training total.
    - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
    - c. Total days of training shall be broken into not more than separate training classes.
    - d. Each training class shall be not less than consecutive day(s).
- C. Training Schedule:
  - 1. Schedule training with Owner 20 business days before expected Substantial Completion.
  - 2. Schedule training to provide Owner with at least 10 business days of notice in advance of training.
  - 3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15 -minute break between sessions. Morning and afternoon sessions shall be separated by 30 -minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
  - 4. Provide staggered training schedule as requested by Owner.
- D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
  2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
  3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
  4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
  5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.
- E. Training Attendee Headcount:
1. Plan in advance of training for two attendees.
  2. Make allowance for Owner to add up to one attendee(s) at time of training.
  3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.
- F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:
1. High school education and degree.
  2. Basic user knowledge of computers and office applications.
  3. Basic knowledge of HVAC systems.
  4. Basic knowledge of DDC systems.
  5. Basic knowledge of DDC system and products installed.
- G. Attendee Training Manuals:
1. Provide each attendee with a color hard copy of all training materials and visual presentations.
  2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
  3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.
- H. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
  2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.
- I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
    - a. Daily operators.
    - b. Advanced operators.
    - c. System managers and administrators.
  2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.
- J. Training Outline:
1. Submit training outline for Owner review at least 10 business day before scheduling training.
  2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.
- K. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
  2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
  3. Provide as much of training located on-site as deemed feasible and practical by Owner.
  4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
  5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.
- L. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
  2. Provide capability to remotely access to Project DDC system for use in training.
  3. Provide a workstation for use by each attendee.
- M. Training Content for Daily Operators:
1. Basic operation of system.
  2. Understanding DDC system architecture and configuration.
  3. Understanding each unique product type installed including performance and service requirements for each.
  4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
  5. Operating operator workstations, printers and other peripherals.
  6. Logging on and off system.



7. Accessing graphics, reports and alarms.
  8. Adjusting and changing set points and time schedules.
  9. Recognizing DDC system malfunctions.
  10. Understanding content of operation and maintenance manuals including control drawings.
  11. Understanding physical location and placement of DDC controllers and I/O hardware.
  12. Accessing data from DDC controllers.
  13. Operating portable operator workstations.
  14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
  15. Running each specified report and log.
  16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
  17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
  18. Executing digital and analog commands in graphic mode.
  19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
  20. Demonstrating DDC system performance through trend logs and command tracing.
  21. Demonstrating scan, update, and alarm responsiveness.
  22. Demonstrating spreadsheet and curve plot software, and its integration with database.
  23. Demonstrating on-line user guide, and help function and mail facility.
  24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
  25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
    - a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
    - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
    - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
    - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
    - f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
    - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.
- N. Training Content for Advanced Operators:
1. Making and changing workstation graphics.
  2. Creating, deleting and modifying alarms including annunciation and routing.

3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
  4. Creating, deleting and modifying reports.
  5. Creating, deleting and modifying points.
  6. Creating, deleting and modifying programming including ability to edit control programs off-line.
  7. Creating, deleting and modifying system graphics and other types of displays.
  8. Adding DDC controllers and other network communication devices such as gateways and routers.
  9. Adding operator workstations.
  10. Performing DDC system checkout and diagnostic procedures.
  11. Performing DDC controllers operation and maintenance procedures.
  12. Performing operator workstation operation and maintenance procedures.
  13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
  14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
  15. Adjusting, calibrating and replacing DDC system components.
- O. Training Content for System Managers and Administrators:
1. DDC system software maintenance and backups.
  2. Uploading, downloading and off-line archiving of all DDC system software and databases.
  3. Interface with Project-specific, third-party operator software.
  4. Understanding password and security procedures.
  5. Adding new operators and making modifications to existing operators.
  6. Operator password assignments and modification.
  7. Operator authority assignment and modification.
  8. Workstation data segregation and modification.
- P. Video of Training Sessions:
1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
  2. Stamp each recording file with training session number, session name and date.
  3. Provide Owner with copies of digital files on DVDs or flash drives for later reference and for use in future training.
  4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230923

## SECTION 230923.12 - CONTROL DAMPERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes control dampers and actuators for DDC systems.
- B. Related Requirements:
  - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
  - 2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.12.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal:
  - 1. Schedule and design calculations for control dampers and actuators, including the following.
    - a. Flow at project design and minimum flow conditions.
    - b. Face velocity at project design and minimum airflow conditions.
    - c. Pressure drop across damper at project design and minimum airflow conditions.
    - d. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    - e. Maximum close-off pressure.
    - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Delegated Design: Engage a qualified professional, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.
- D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- E. Selection Criteria:
  - 1. Control dampers shall be suitable for operation at following conditions:
    - a. Outdoor Air: .
  - 2. Fail positions unless otherwise indicated:
    - a. Outdoor Air: **Close** .
  - 3. Select modulating dampers for a pressure drop of **2** percent of fan total static pressure unless otherwise indicated.

### 2.2 RECTANGULAR CONTROL DAMPERS

- A. General Requirements:
  - 1. Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.
  - 2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
- B. Rectangular Dampers with Aluminum Airfoil Blades:
  - 1. Performance:
    - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.
    - b. Pressure Drop: 0.05-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
    - c. Velocity: Up to 6000 fpm.
    - d. Temperature: Minus 40 to plus 185 deg F.

- e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
  - f. Damper shall have AMCA seal for both air leakage and air performance.
2. Construction:
- a. Frame:
    - 1) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch thick.
    - 2) Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch.
    - 3) Width not less than 5 inches.
  - b. Blades:
    - 1) Hollow, airfoil, extruded aluminum.
    - 2) Parallel or opposed blade configuration as required by application.
    - 3) Material: ASTM B 211, Alloy 6063 T5 aluminum, 0.07 inch thick.
    - 4) Width not to exceed 6 inches.
    - 5) Length as required by close-off pressure, not to exceed 48 inches.
  - c. Seals:
    - 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
    - 2) Jamb: Stainless steel, compression type.
  - d. Axles: 0.5-inch-diameter **plated or stainless** steel, mechanically attached to blades.
  - e. Bearings:
    - 1) Molded synthetic or stainless-steel sleeve mounted in frame.
    - 2) Where blade axles are installed in vertical position, provide thrust bearings.
  - f. Linkage:
    - 1) Concealed in frame.
    - 2) Constructed of aluminum and **plated or stainless** steel.
    - 3) Hardware: Stainless steel.
  - g. Transition:
    - 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
    - 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
    - 3) Damper size and sleeve shall be connection size plus 2 inches.
    - 4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
    - 5) Sleeve material shall match adjacent duct.

- h. Additional Corrosion Protection for Corrosive Environments:
  - 1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
  - 2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.
  
- 3. Airflow Measurement:
  - a. Where indicated, provide damper assembly with integral airflow monitoring.
  - b. Zero- to 10-V dc or 4- to 20-mA scaled output signal for remote monitoring of actual airflow.
  - c. Accuracy shall be within 5 percent of the actual flow rate between the range of minimum and design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assembly as required to comply with the stated accuracy over the entire modulating range.
  - d. Provide a straightening device as part of the flow measurement assembly to achieve the specified accuracy with configuration indicated.
  - e. Suitable for operation in untreated and unfiltered air.
  - f. Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
  - g. Provide automatic zeroing feature.
  
- 4. Airflow Control:
  - a. Where indicated, provide damper assembly with integral airflow measurement and control.
  - b. A factory-furnished and -calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.
  - c. The controller and actuator shall communicate to control the desired airflow.
  - d. The controller shall receive a zero- to 10-V dc input signal and report a zero- to 20-mA output signal that is proportional to the airflow.
  - e. Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm.
  - f. Ambient Operating Temperature Range: Minus 40 to plus 140 deg F.
  - g. Ambient Operating Humidity Range: 5 to 95 percent relative humidity, non-condensing.
  - h. Provide unit with control transformer rated for not less than 85 VA. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
  - i. Provide screw terminals for interface to field wiring.
  - j. Factory mount electronics within a NEMA 250, Type 1 painted steel enclosure.
  
- C. Rectangular Dampers with Steel Airfoil Blades:
  - 1. Performance:
    - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.

- b. Pressure Drop: 0.06-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
  - c. Velocity: Up to 6000 fpm.
  - d. Temperature: Minus 40 to plus 185 deg F.
  - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
  - f. Damper shall have AMCA seal for both air leakage and air performance.
2. Construction:
- a. Frame:
    - 1) Material: ASTM A 653/A 653M galvanized-steel profiles, 0.06 inch thick.
    - 2) Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch.
    - 3) Width not less than 5 inches.
  - b. Blades:
    - 1) Hollow, airfoil, galvanized steel.
    - 2) Parallel or opposed blade configuration as required by application.
    - 3) Material: ASTM A 653/A 653M galvanized steel, 0.05 inch thick.
    - 4) Width not to exceed 6 inches.
    - 5) Length as required by close-off pressure, not to exceed 48 inches.
  - c. Seals:
    - 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
    - 2) Jambs: Stainless steel, compression type.
  - d. Axles: 0.5-inch-diameter steel, mechanically attached to blades.
  - e. Bearings:
    - 1) Stainless steel mounted in frame.
    - 2) Where blade axles are installed in vertical position, provide thrust bearings.
  - f. Linkage:
    - 1) Concealed in frame.
    - 2) Constructed of aluminum and **plated or stainless** steel.
    - 3) Hardware: Stainless steel.
  - g. Transition:
    - 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
    - 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
    - 3) Damper size and sleeve shall be connection size plus 2 inches.

- 4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
- 5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:

- 1) Provide epoxy finish for surfaces in contact with airstream.
- 2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

D. Rectangular Dampers with Aluminum Flat Blades:

1. Performance:

- a. Leakage: Leakage shall not exceed 3.2 cfm/sq. ft. against 1-in. wg differential static pressure.
- b. Pressure Drop: 0.07-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
- c. Velocity: Up to 2000 fpm.
- d. Temperature: Minus 50 to plus 250 deg F.
- e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, not to exceed 3-in. wg.
- f. Damper shall have AMCA seal for both air leakage and air performance.

2. Construction:

a. Frame:

- 1) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.12 inch thick.
- 2) Hat-shaped channel.
- 3) Width not less than 5 inches.

b. Blades:

- 1) Flat blades of extruded aluminum.
- 2) Parallel or opposed blade configuration as required by application.
- 3) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.12 inch thick.
- 4) Width not to exceed 6 inches.
- 5) Length as required by close-off pressure, not to exceed 48 inches.

c. Seals:

- 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl or plastic composite.
- 2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch-diameter steel, mechanically attached to blades.

e. Bearings:



- 1) Molded-synthetic sleeve, mounted in frame.
  - 2) Where blade axles are installed in vertical position, provide thrust bearings.
- f. Linkage:
- 1) Concealed in frame.
  - 2) Constructed of steel.
  - 3) Hardware: Stainless steel.
- g. Transition:
- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
  - 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
  - 3) Damper size and sleeve shall be connection size plus 2 inches.
  - 4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
  - 5) Sleeve material shall match adjacent duct.
- h. Additional Corrosion Protection for Corrosive Environments:
- 1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
  - 2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.
- E. Rectangular Dampers with Steel Flat Blades:
1. Performance:
    - a. Leakage: Leakage shall not exceed 4.8 cfm/sq. ft. against 1-in. wg differential static pressure.
    - b. Pressure Drop: 0.1-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
    - c. Velocity: Up to 1500 fpm.
    - d. Temperature: Minus 25 to plus 180 deg F.
    - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, not to exceed 4-in. wg.
    - f. Damper shall have AMCA seal for both air leakage and air performance.
  2. Construction:
    - a. Frame:
      - 1) Material: **Galvanized or stainless** steel, 0.06 inch thick.
      - 2) Hat-shaped channel.
      - 3) Width not less than 5 inches.
    - b. Blades:

- 1) Flat blades with multiple grooves positioned axially for reinforcement.
  - 2) Parallel or opposed blade configuration as required by application.
  - 3) Material: **Galvanized or stainless** steel, 0.06 inch thick.
  - 4) Width not to exceed 6 inches.
  - 5) Length as required by close-off pressure, not to exceed 48 inches.
- c. Seals:
- 1) Blades: Replaceable, mechanically attached, PVC-coated polyester.
  - 2) Jams: Stainless steel, compression type.
- d. Axles: 0.5-inch-diameter **plated or stainless** steel, mechanically attached to blades.
- e. Bearings:
- 1) Molded-synthetic sleeve, mounted in frame.
  - 2) Where blade axles are installed in vertical position, provide thrust bearings.
- f. Linkage:
- 1) Concealed in frame.
  - 2) Constructed of **plated or stainless** steel.
  - 3) Hardware: Stainless steel.

### 2.3 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

- A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
- B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
- C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
- D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
- E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
- F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
- G. Provide mounting hardware and linkages for connecting actuator to damper.
- H. Select actuators to fail in desired position in the event of a power failure.

I. Actuator Fail Positions:

1. Outdoor Air: **Close** .

2.4 ELECTRIC AND ELECTRONIC ACTUATORS

A. Type: Motor operated, with or without gears, electric and electronic.

B. Voltage:

1. **Voltage selection is delegated to professional designing control system** .
2. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

C. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

D. Field Adjustment:

1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

E. Two-Position Actuators: Single direction, spring return or reversing type.

F. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
  - a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
  - b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for **zero- to 10- V dc and 4- to 20-mA** signals.

- c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink or source controller.
- d. Programmable Multi-Function:
  - 1) Control input, position feedback, and running time shall be factory or field programmable.
  - 2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
  - 3) Service data, including at a minimum, number of hours powered and number of hours in motion.

G. Position Feedback:

- 1. **Equip** two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of position.
- 2. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

H. Fail-Safe:

- 1. Where indicated, provide actuator to fail to an end position.
- 2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
- 3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

I. Integral Overload Protection:

- 1. Provide against overload throughout the entire operating range in both directions.
- 2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

J. Damper Attachment:

- 1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
- 2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
- 3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

K. Temperature and Humidity:

- 1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of **minus 20 to plus 120 deg F**.
- 2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from **5 to 95** percent relative humidity, non-condensing.

L. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with a heater and controller where required by application.

M. Stroke Time:

1. Operate damper from fully closed to fully open within **60** seconds.
2. Operate damper from fully open to fully closed within **60** seconds.
3. Move damper to failed position within **30** seconds.
4. Select operating speed to be compatible with equipment and system operation.
5. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

N. Sound:

1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

### PART 3 - EXECUTION

#### 3.1 CONTROL-DAMPER APPLICATIONS

A. Control Dampers:

- B. Select from damper types indicated in "Control Dampers" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
1. Rectangular Outdoor Air Duct Applications with SMACNA Construction Class and Velocities to: **Rectangular dampers with aluminum airfoil blades.**

#### 3.2 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Seal penetrations made in fire-rated and acoustically rated assemblies.
- E. Fastening Hardware:

1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
  2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- G. Corrosive Environments:
1. Use products that are suitable for environment to which they will be subjected.
  2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
    - a. Laboratory exhaust airstreams.
    - b. Process exhaust airstreams.
  3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
  4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
  5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.3 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.4 CONTROL DAMPERS

- A. Install smooth transitions, not exceeding **30** degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
- B. Clearance:

1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

C. Service Access:

1. Dampers and actuators shall be accessible for visual inspection and service.
2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

E. Attach actuator(s) to damper drive shaft.

F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

G. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

H. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."Section 16075 "Electrical Identification."

I. Install engraved phenolic nameplate with damper identification on damper.

### 3.5 CHECKOUT PROCEDURES

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is unobstructed.

### 3.6 ADJUSTMENT, CALIBRATION, AND TESTING:

- A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

- B. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- C. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.12



## SECTION 230923.16 - GAS INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes the Following Gas Instruments:

1. Carbon-dioxide sensors and transmitters.
2. VOC sensors and transmitters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.16.

#### 1.2 DEFINITIONS

A. NDIR: Nondispersive infrared.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals: Product data of carbon-dioxide instruments for use in showing compliance with requirements in ASHRAE 62.1.

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include diagrams for power, signal, and control wiring.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

### PART 2 - PRODUCTS

#### 2.1 CARBON-DIOXIDE SENSORS AND TRANSMITTERS

A. Description:

1. NDIR technology or equivalent technology providing long-term stability and reliability.
2. Two-wire, 4-20 mA output signal, linearized to carbon-dioxide concentration in ppm.

B. Construction:

1. House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 1 enclosure for wall-mounted space applications and NEMA 250, Type 4 for duct-mounted applications.
2. Equip with digital display for continuous indication of carbon-dioxide concentration.

C. Performance:

1. Measurement Range: Zero to 2000 ppm.
2. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.
3. Repeatability: Within 1 percent of full scale.
4. Temperature Dependence: Within 0.05 percent of full scale over an operating range of 25 to 110 deg F.
5. Long-Term Stability: Within 5 percent of full scale after more than five years.
6. Response Time: Within 60 seconds.
7. Warm-up Time: Within five minutes.

D. Provide calibration kit. Turn over to Owner at start of warranty period.

## 2.2 VOC SENSORS AND TRANSMITTERS

A. Description:

1. VOC sensor shall use an oxidizing element that varies resistance with contaminant gases.
2. Senses and responds to combined concentration of more than 30 contaminants commonly found in indoor environments.

B. Output Signal: Zero to 10-V dc with minimum load resistance of 4000 ohms.

C. Performance:

1. Measurement Range: Zero to 100 percent.
2. Ambient Temperature: 32 to 140 deg F.
3. Ambient Relative Humidity: 5 to 95 percent non-condensing.

D. Enclosure: Lexan.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to seismic loads.

D. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including but not limited to, the following:
  - a. Laboratory exhaust airstreams.
  - b. Process exhaust airstreams.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.2 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.3 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Install transmitters for gas associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.

2. Install gas switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
3. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
4. Install instruments in dry gas and non-condensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
  - a. Make every effort to mount at 60 inches.

- C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification on face.

### 3.5 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate gas instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.16

## SECTION 230923.19 - MOISTURE INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes moisture switches, sensors, and transmitters.
- B. Related Requirements:
  - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
  - 2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.19.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 MOISTURE SWITCHES

- A. Humidistat for Duct Applications:
  - 1. Description:
    - a. Two-position control.
    - b. Field-adjustable set point.
    - c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Performance:
  - a. Relative Humidity Range: 15 to 95 percent.
  - b. Relative Humidity Differential: 5 percent.
  - c. Ambient Temperature: 40 to 135 deg F.
  - d. Voltage: 120-V ac.
  - e. Current: 7.2 FLA.
  - f. Switch Type: SPDT snap switch.

3. Construction:
  - a. Enclosure: Metal, NEMA 250, Type 1.
  - b. Electrical Connections: Screw terminals.

B. Humidistat for Space Applications:

1. Description:
  - a. Two-position control.
  - b. Field-adjustable set point.
  - c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Performance:
  - a. Relative Humidity Range: 10 to 90 percent.
  - b. Relative Humidity Differential: 5 percent.
  - c. Ambient Temperature: 40 to 135 deg F.
  - d. Voltage: 24-V ac.
  - e. Pilot Duty: 60 VA.
  - f. Switch Type: SPDT snap switch.

3. Construction:
  - a. Enclosure: Plastic, NEMA 250, Type 1.
  - b. Electrical Connections: Cable, 6 inches long.

## 2.2 MOISTURE SENSORS AND TRANSMITTERS

A. Sensors and Transmitters with Digital Display:

1. Performance:
  - a. Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 2.5 percent from 90 to 100 percent relative humidity when operating between 60 to 77 deg F.
  - b. Relative Humidity Range: Zero to 100 percent.
  - c. Factory calibrated and NIST traceable with certificate included.

2. Construction:

- a. Provide housing with integral sensor for room applications.
  - b. Provide housing with remote sensor probe for ducted applications.
    - 1) Duct Sensor Body: 300 series stainless steel or chrome-plated aluminum, at least 2 inches long for duct-mounted applications.
    - 2) Provide sensor with cable for field installation in conduit.
    - 3) For duct-mounted applications, thread the sensor assembly for connection to a threaded mounting flange.
  - c. Provide general-purpose humidity sensor unless application requires special requirements. Provide sensor with sintered stainless-steel filter for duct applications.
  - d. Housing shall be ABS/PC plastic or powder-coated aluminum.
  - e. Housing Classification: NEMA 250, Type 4 or 4X.
  - f. Provide housing with wall-mounting plate.
3. Output Signal: 2-wire, 4- to 20-mA output signal with a drive capacity of at least 500 ohms at 24-V dc.
  4. Provide unit with a digital display of relative humidity in percent.
- B. Sensor and Transmitter without Display:
1. Performance:
    - a. Relative Humidity Range: Zero to 100 percent.
    - b. Accuracy: Within 2 percent.
    - c. Operating Temperatures: Minus 30 to 130 deg F.
    - d. Hysteresis: Within 1 percent.
  2. Construction:
    - a. Duct-type sensor for duct-mounted applications. Integral-type sensor for room or space applications.
    - b. Sensor Body: 300 series stainless steel, 6 inches long for duct-mounted applications.
    - c. For outdoor applications, install circuitry in a NEMA 250, Type 4 or 4X enclosure.
  3. Output Signal:
    - a. Two-wire, 4- to 20-mA output signal with a drive capacity of at least 600 ohms at 24-V dc.
    - b. Non-interacting zero and span adjustments.

## PART 3 - EXECUTION

### 3.1 MOISTURE INSTRUMENT APPLICATIONS

A. : .



### 3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- E. Corrosive Environments:
  - 1. Use products that are suitable for environment to which they are subjected.
  - 2. If possible, avoid or limit use of materials in corrosive environments.
  - 3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
  - 4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.3 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.4 MOISTURE INSTRUMENTS INSTALLATION

- A. Mounting Location: Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code, state, and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
  - a. Make every effort to mount at 60 inches.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

3.6 CHECKOUT PROCEDURES

- A. Check installed products before continuity tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.19

## SECTION 230923.21 - MOTION INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. PIR motion sensors.
2. Ultrasonic motion sensors.
3. Dual-technology motion sensors.

##### B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.21.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

##### B. Shop Drawings:

1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

#### 1.3 INFORMATIONAL SUBMITTALS

##### A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to visual range and obstructions.
2. Wall- and ceiling-mounted instruments located in finished space showing relationship to other installed devices.

##### B. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 INDOOR MOTION SENSORS

- A. Description: Wall- or ceiling-mounted, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn on when covered area is occupied and off when unoccupied; with a time delay for turning off, adjustable over a minimum range of 1 to 15 minutes.
  2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
  3. Relay Unit: Dry contacts rated for 20-A load at 120- and 277-V ac. Power supply to sensor shall be 24-V dc, 150 mA, Class 2 power source as defined by NFPA 70.
  4. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch knock out in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  5. Indicator: Digital display, to show when motion is being detected during testing and normal operation of the sensor.
  6. Bypass Switch: Override the on function in case of sensor failure.
- B. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in coverage area.
1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
  2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
  3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
- C. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in coverage area.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.
  5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.
- D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in coverage area. A particular technology or combination of technologies that controls on-off functions shall be field selectable by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling. Apply occupancy detectors where indicated.

### PART 3 - EXECUTION

#### 3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Coordinate layout and installation of wall-mounted devices with other wall-mounted devices. Align centerline with adjacent devices. Align centerline with devices above.
- C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

#### 3.2 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Motion instruments will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 230923.21

## SECTION 230923.22 - POSITION INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes position limit switches for use in direct-digital control systems for HVAC.
- B. Related Requirements:
  - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
  - 2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.22.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Include number-coded identification system for unique identification of wiring.

### PART 2 - PRODUCTS

#### 2.1 POSITION LIMIT SWITCHES

- A. Description: Select type of actuating head (plunger, roller lever, or rod) to suit application.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Performance:
  - 1. Life expectancy: Not less than 30 million mechanical operations and 750,000 electrical operations.
  - 2. Operating Frequency: 300 mechanical operations per minute and 30 electrical operations per minute.
  - 3. Voltage: 125-, 250-, 480-, and 600-V ac or 8-, 12-, 14-, 24-, 30-, 48-, 125-, and 250-V dc, as required by application.
  - 4. Current Rating: As required by application.

5. Temperature Rise: 50 deg C.
6. Ambient Temperature: 14 to 175 deg F.
7. Ambient Relative Humidity: 35 to 95 percent.

C. Construction:

1. NEMA 250, Type 4X enclosure.
2. Switch Type: SPDT or DPDT, as required by application.
3. Status indicator integral to switch. Field switchable to light when contacts are actuated and operating, or contacts are free and not operating.
4. Electrical Connection: Screw or plug-in terminals.
5. Conduit Connection: NPS 1/2.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a force.
- C. Fastening Hardware:
  1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
  3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- E. Corrosive Environments:
  1. Use products that are suitable for environment to which they are subjected.
  2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to:
    - a. Laboratory exhaust airstreams.
    - b. Process exhaust airstreams.
  3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.



4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.2 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.3 POSITION INSTRUMENTS INSTALLATION

- A. Mounting Location:
  1. Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, and conduit to final location.
  2. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

END OF SECTION 230923.22

## SECTION 230923.23 - PRESSURE INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.

##### B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.23.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

##### B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

#### 1.3 INFORMATIONAL SUBMITTALS

##### A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

##### A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 AIR-PRESSURE SENSORS

#### A. Duct Insertion Static Pressure Sensor:

1. Insertion length shall be at **4 inches**.
2. Sensor with four radial holes of 0.04-inch diameter.
3. **Brass or stainless-steel** construction.
4. Sensor with threaded end support, sealing washers and nuts.
5. Connection: NPS 1/4 compression fitting.
6. Suitable for flat oval, rectangular, and round duct configurations.

#### B. Outdoor Static Pressure Sensor:

1. Provides average outdoor pressure signal.
2. Sensor with no moving parts.
3. Kit includes sensor, vinyl tubing mounting hardware.

#### C. Space Static Pressure Sensor for Wall Mounting:

1. 100-micron filter mounted in stainless-steel wall plate senses static pressure.
2. Wall plate provided with gasket and screws, and sized to fit standard single-gang electrical box.
3. Back of sensor plate fitted with brass barbed fitting for tubing connection.

#### D. Space Static Pressure Sensor for Recessed Ceiling Mounting:

1. **Stainless-steel** round plate with perforated center arranged to sense space static pressure. Exposed surfaces provided with brush finish.
2. Sensor intended for flush mount on face of ceiling with pressure chamber recessed in ceiling plenum.
3. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch fitting for concealed tubing connection.
4. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360 degree radial source.

### 2.2 AIR-PRESSURE SWITCHES

#### A. Air-Pressure Differential Switch:

1. Diaphragm operated to actuate an SPDT snap switch.
  - a. Fan safety shutdown applications: Switch with manual reset.
2. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
3. Enclosure Conduit Connection: Knock out or threaded connection.

4. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
5. High and Low Process Connections: Threaded, NPS 1/8.
6. Enclosure:
  - a. Dry Indoor Installations: NEMA 250, Type 1.
  - b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
  - c. Hazardous Environments: Explosion proof.
7. Operating Data:
  - a. Electrical Rating: 15 A at 120- to 480-V ac.
  - b. Pressure Limits:
    - 1) Continuous: 45 inches wg.
    - 2) Surge: 10 psig.
  - c. Temperature Limits: Minus 30 to 180 deg F.
  - d. Operating Range: Approximately 2 times set point.
  - e. Repeatability: Within 3 percent.
  - f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 AIR-PRESSURE TRANSMITTERS

### A. Air-Pressure Differential Transmitter:

1. Performance:
  - a. Range: Approximately 2 times set point.
  - b. Accuracy: Within **0.5** percent of the span at reference temperature of 70 deg F.
  - c. Hysteresis: Within 0.02 percent of the span.
  - d. Repeatability: Within 0.05 percent of the calibrated span.
  - e. Stability: Within 0.25 percent of span per year.
  - f. Overpressure: 15 psig.
  - g. Temperature Limits: Minus 20 to 160 deg F.
  - h. Compensate Temperature Limits: 35 to 135 deg F.
  - i. Thermal Effects: 0.015 percent of full scale per degree F.
  - j. Warm-up Time: Within 5 seconds.
  - k. Response Time: .
  - l. Shock and vibration shall not harm the transmitter.
2. Output Signals:
  - a. Analog Current Signal:
    - 1) Two-wire, 4- to 20-mA dc current source.
    - 2) Signal capable of operating into 1000-ohm load.
  - b. Analog Voltage Signal:

- 1) Three wire, zero to 5 V.
  - 2) Minimum Load Resistance: 1000 ohms.
3. Operator Interface:
    - a. Zero and span adjustments within 10 percent of full span.
    - b. Potentiometer adjustments located on face of transmitter.
  4. Construction:
    - a. Type 300 stainless-steel enclosure.
    - b. Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on front of instrument enclosure.
    - c. Screw terminal block for wire connections.
    - d. Vertical plane mounting.
    - e. NEMA 250, Type 2.
    - f. Mounting Bracket: Appropriate for installation.
    - g. Reverse wiring protected.
    - h. Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.
- B. Air-Pressure Differential Indicating Transmitter:
1. Performance:
    - a. Range: Approximately 2 times set point.
    - b. Accuracy Including Hysteresis and Repeatability: Within 1 percent of full scale at 77 deg F.
    - c. Stability: Within 1 percent of full scale per year.
    - d. Overpressure: 10 psig.
    - e. Temperature Limits: 20 to 120 deg F.
    - f. Thermal Effects: 0.055 percent of full scale per degree F.
  2. Display: Four-digit digital display with minimum 0.4-inch-high numeric characters.
  3. Operator Interface:
    - a. Zero and span adjustments.
    - b. Selectable engineering units.
  4. Analog Output Current Signal:
    - a. Two-wire, 4- to 20-mA dc current source.
    - b. Signal capable of operating into a 1200-ohm load.
  5. Construction:
    - a. Plastic casing with clear plastic cover.
    - b. Integral fittings for plastic tubing connections on side of instrument case for high- and low-pressure connections.
    - c. Terminal block for wire connections.
    - d. Vertical plane mounting.

- e. NEMA 250, Type 1.
- f. Nominal 4-inch diameter face.
- g. Mounting Bracket: Appropriate for installation.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a force.
- C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- F. Corrosive Environments:
  - 1. Use products that are suitable for environment to which they are subjected.
  - 2. If possible, avoid or limit use of materials in corrosive environments.
  - 3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
  - 4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

#### 3.2 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.3 PRESSURE INSTRUMENT INSTALLATION

#### A. Mounting Location:

- 1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
- 2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
- 3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- 4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- 5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- 6. Install instruments (except pressure gages) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
- 7. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

#### B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

#### C. Duct Pressure Sensors:

- 1. Install sensors using manufacturer's recommended upstream and downstream distances.
- 2. Unless indicated on Drawings, locate sensors approximately percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.
- 3. Install mounting hardware and gaskets to make sensor installation airtight.
- 4. Route tubing from the sensor to transmitter.
- 5. Use compression fittings at terminations.
- 6. Install sensor in accordance with manufacturer's instructions.
- 7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

#### D. Outdoor Pressure Sensors:

1. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
2. Locate wall-mounted sensor in an inconspicuous location.
3. Submit sensor location for approval before installation.
4. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.
5. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
6. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
7. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
8. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.

E. Air-Pressure Differential Switches:

1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
2. A single sensor may be used to share a common signal to multiple pressure instruments.
3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route NPS 3/8 tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.
6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an easily accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within **50 feet**; otherwise, locate switch in vicinity of system connection.

F. Liquid-Pressure Differential Switches:

1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than **NPS 1/2**. Install bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

G. Liquid-Pressure Transmitters:



1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than **NPS 1/2**. Install bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

### 3.5 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

### 3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

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END OF SECTION 230923.23

## SECTION 230923.24 - SPEED INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes speed switches for direct-digital controls for HVAC.
- B. Related Requirements:
  - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
  - 2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.24.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Include number-coded identification system for unique identification of wiring.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 ROTATIONAL SPEED SWITCHES

- A. Rotational Speed Switch (Non-Contact Type):
  - 1. Description:
    - a. Speed switch, sensor, and electronics housed in enclosure.
    - b. Shaft-end-mounted disc, or split collar wrap generates an alternating magnetic field sensed by the switch.
    - c. Dust, dirt, and grease proof.

- d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.
2. Performance:
  - a. Field-Adjustable Range: **100 to 5000** rpm.
  - b. Temperature Limits: Minus 40 to 140 deg F.
  - c. Electrical Rating: 5 A at 115-V ac.
  - d. Switch Type: SPDT.
  - e. Gap Distance: Approximately 0.375 inch.
3. Operator Interface: Potentiometer.
4. Enclosure Construction:
  - a. **PVC**.
  - b. Removable cover.
  - c. NEMA 250, Type 4X.
  - d. Electrical Connection: Wiring, 12 inches long, furnished with switch.
  - e. Conduit Connection: 1-inch trade size.
5. Disc, Guard, and Mounting Bracket Construction:
  - a. Magnetic Disc: Nylon or PVC.
  - b. Disc Guard: Stainless steel.
  - c. Mounting Bracket: Aluminum with stainless-steel shaft.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support speed-switch wiring and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Fastening Hardware:
  1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.2 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.3 SPEED-SWITCH INSTALLATIONS

- A. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

END OF SECTION 230923.24

## SECTION 230923.27 - TEMPERATURE INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Air temperature sensors.
2. Air temperature switches.
3. Air temperature RTD transmitters.
4. Liquid and steam temperature sensors.
5. High-end, commercial-grade, liquid and steam temperature sensors.
6. Liquid temperature switches.
7. High-end, commercial-grade, liquid and steam temperature transmitters.

##### B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.27.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

##### B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

#### 1.3 INFORMATIONAL SUBMITTALS

##### A. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

#### A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
  - a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.
2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:
  - a. Outdoors, Protected: **Type 3** .
  - b. Outdoors, Unprotected: **Type 4X**.
  - c. Indoors, Heated with Filtered Ventilation: **Type 2**.
  - d. Indoors, Heated with Non-Filtered Ventilation: **Type 12**.
  - e. Indoors, Heated and Air Conditioned: **Type 1**.
  - f. Mechanical Equipment Rooms:
    - 1) Air-Moving Equipment Rooms: **Type 12**.
  - g. Localized Areas Exposed to Washdown: **Type 4X**.
  - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: **Type 2** .
  - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: .
  - j. Hazardous Locations: Explosion-proof rating for condition.

### 2.2 AIR TEMPERATURE SENSORS

#### A. Platinum RTDs: Common Requirements:

1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:
  - a. Range: Minus 50 to 275 deg F.
  - b. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
  - c. Repeatability: Within 0.5 deg F.

- d. Self-Heating: Negligible.
4. Transmitter Requirements:
  - a. Transmitter required for each 100-ohm RTD.
  - b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
- B. Platinum RTD, Single-Point Air Temperature Duct Sensors:
  1. **100 or 1000** ohms.
  2. Temperature Range: Minus 50 to 275 deg F
  3. Probe: Single-point sensor with a stainless-steel sheath.
  4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
  5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  6. Gasket for attachment to duct or equipment to seal penetration airtight.
  7. Conduit Connection: 1/2-inch
- C. Platinum RTD, Air Temperature Averaging Sensors:
  1. **100 or 1000** ohms.
  2. Temperature Range: Minus 50 to 275 deg F
  3. Multiple sensors to provide average temperature across entire length of sensor.
  4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
  5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
  6. Length: As required by application to cover entire cross section of air tunnel.
  7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  8. Gasket for attachment to duct or equipment to seal penetration airtight.
  9. Conduit Connection: 1/2-inch
- D. Platinum RTD Outdoor Air Temperature Sensors:
  1. **100 or 1000** ohms.
  2. Temperature Range: Minus 50 to 275 deg F
  3. Probe: Single-point sensor with a stainless-steel sheath.
  4. Solar Shield: Stainless steel.
  5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
  6. Conduit Connection: 1/2-inch trade size.
- E. Platinum RTD Space Air Temperature Sensors:
  1. **100 or 1000** ohms.
  2. Temperature Range: Minus 50 to 212 deg F
  3. Sensor assembly shall include a temperature sensing element mounted under a cover.
  4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.



5. Concealed wiring connection.
- F. Thermal Resistors (Thermistors): Common Requirements:
1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
  2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
  3. Performance Characteristics:
    - a. Range: Minus 50 to 275 deg F.
    - b. Interchangeable Accuracy: At 77 deg F within 0.5 deg F.
    - c. Repeatability: Within 0.5 deg F.
    - d. Drift: Within 0.5 deg F over 10 years.
    - e. Self-Heating: Negligible.
  4. Transmitter optional, contingent on compliance with end-to-end control accuracy.
- G. Thermistor, Single-Point Duct Air Temperature Sensors:
1. Temperature Range: Minus 50 to 275 deg F
  2. Probe: Single-point sensor with a stainless-steel sheath.
  3. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
  4. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  5. Gasket for attachment to duct or equipment to seal penetration airtight.
  6. Conduit Connection: 1/2- inch trade size.
- H. Thermistor Averaging Air Temperature Sensors:
1. Temperature Range: Minus 50 to 275 deg F
  2. Multiple sensors to provide average temperature across entire length of sensor.
  3. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
  4. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
  5. Length: As required by application to cover entire cross section of air tunnel.
  6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  7. Gasket for attachment to duct or equipment to seal penetration airtight.
  8. Conduit Connection: 1/2-inch trade size.
- I. Thermistor Outdoor Air Temperature Sensors:
1. Temperature Range: Minus 50 to 275 deg F
  2. Probe: Single-point sensor with a stainless-steel sheath.
  3. Solar Shield: Stainless steel.
  4. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
  5. Conduit Connection: 1/2-inch trade size.
- J. Thermistor Space Air Temperature Sensors:

1. Temperature Range: Minus 50 to 212 deg F
2. Sensor assembly shall include a temperature sensing element mounted under a cover.
3. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
4. Concealed wiring connection.

K. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:

1. ohm platinum RTD.
2. Thermistor:
  - a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.
  - b. Thermistor drift shall be less than plus or minus 0.5 deg F over 10 years.
3. Temperature Transmitter Requirements:
  - a. Mating transmitter required with each 100-ohm RTD.
  - b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.
4. Provide digital display of sensed temperature.
5. Provide sensor with local control.
  - a. Local override to turn HVAC on.
  - b. Local adjustment of temperature set point.
  - c. Both features shall be capable of manual override through control system operator.

2.3 AIR TEMPERATURE SWITCHES

A. Thermostat and Switch for Low Temperature Control in Duct Applications:

1. Description:
  - a. Two-position control.
  - b. Field-adjustable set point.
  - c. Manual reset.
  - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Performance:
  - a. Operating Temperature Range: 15 to 55 deg F.
  - b. Temperature Differential: 5 deg F, non-adjustable and additive.
  - c. Enclosure Ambient Temperature: Minus 20 to 140 deg F.
  - d. Sensing Element Maximum Temperature: 250 deg F.
  - e. Voltage: 120-V ac.
  - f. Current: 16 FLA.
  - g. Switch Type: Two SPDT snap switches operate on coldest 12-inch section along element length.

3. Construction:
  - a. Vapor-Filled Sensing Element: Nominal 20 feet long.
  - b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
  - c. Set-Point Adjustment: Screw.
  - d. Enclosure: Painted metal, NEMA 250, Type 1.
  - e. Electrical Connections: Screw terminals.
  - f. Conduit Connection: 1/2-inch trade size.

B. Thermostat and Switch for High Temperature Control in Duct Applications:

1. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
2. Description:
  - a. Two-position control.
  - b. Field-adjustable set point.
  - c. Manual reset.
  - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Performance:
  - a. Temperature Range: 100 to 160 deg F.
  - b. Temperature Differential: 5 deg F.
  - c. Ambient Temperature: Zero to 260 deg F.
  - d. Voltage: 120-V ac.
  - e. Current: 16 FLA.
  - f. Switch Type: SPDT snap switch.
4. Construction:
  - a. Sensing Element: Helical bimetal.
  - b. Enclosure: Metal, NEMA 250, Type 1.
  - c. Electrical Connections: Screw terminals.
  - d. Conduit Connection: 1/2-inch trade size.

2.4 AIR TEMPERATURE RTD TRANSMITTERS

- A. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
- B. House electronics in NEMA 250 enclosure.
  1. Duct: .
  2. Outdoor: .
  3. Space: Type 1.
- C. Conduit Connection: 1/2-inch
- D. Functional Characteristics:

1. Input:
  - a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
  - b. 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
2. Span (Adjustable):
  - a. Space: 40 to 90 deg F.
  - b. Supply Air Cooling and Heating: 40 to 120 deg F.
  - c. Supply Air Cooling Only: 40 to 90 deg F.
  - d. Supply Air Heating Only: 40 to 120 deg F.
  - e. Exhaust Air: 50 to 100 deg F.
  - f. Return Air: 50 to 100 deg F.
  - g. Mixed Air: Minus 40 to 140 deg F.
  - h. Outdoor: Minus 40 to 140 deg F.
3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc .
4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
5. Match sensor with temperature transmitter and factory calibrate together.

E. Performance Characteristics:

1. Calibration Accuracy: Within 0.1 percent of the span.
2. Stability: Within 0.2 percent of the span for at least 6 months.
3. Combined Accuracy: Within 0.5 percent.

2.5 LIQUID AND STEAM TEMPERATURE SENSORS, COMMERCIAL GRADE

A. RTD:

1. Description:
  - a. Platinum with a value of ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
  - b. Encase RTD in a stainless-steel sheath with a 0.25-inch OD.
  - c. Sensor Length: 4, 6, or 8 inches as required by application.
  - d. Process Connection: Threaded, NPS 1/2
  - e. Two-stranded copper lead wires.
  - f. Powder-coated steel enclosure, NEMA 250, Type 4.
  - g. Conduit Connection: 1/2-inch
  - h. Performance Characteristics:
    - 1) Range: Minus 40 to 210 deg F.
    - 2) Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.

B. Thermowells:

1. Stem: shank formed from solid bar stock.
2. Material: .
3. Process Connection: Threaded, NPS 3/4.
4. Sensor Connection: Threaded, NPS 1/2.
5. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
6. Furnish thermowells installed in insulated pipes and equipment with an extended neck.
7. Length: 4, 6, or 8 inches as required by application.
8. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

## 2.6 LIQUID AND STEAM TEMPERATURE SENSORS, HIGH-END COMMERCIAL GRADE

### A. RTD:

1. Resistance temperature sensors shall comply with IEC 60751, Class B requirements.
2. Platinum with a value of 100 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
3. Encase RTD in a Type 316 stainless-steel sheath with a 0.25-inch OD.
4. Provide -wire, PTFE-insulated, nickel-coated, 22-gage, stranded copper leads.
5. Provide spring-loaded RTDs for thermowell installations.
6. Performance Characteristics:
  - a. Range: Minus 328 to 932 deg F.
  - b. Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.
  - c. Stability: Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F.
  - d. Hysteresis: Within 0.04 percent of range.
  - e. Response Time: 62.8 percent of change in 4 seconds with water flowing across sensor at 3 fps.

### B. Thermowells:

1. Stem: shank formed from solid bar stock.
2. Material: stainless steel.
3. Process Connection: Threaded, NPS 3/4
4. Sensor Connection: Threaded, NPS 1/2
5. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
6. Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends beyond the face of the insulation covering.
7. Length: As required by application and pipe size.
8. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

### C. Connection Heads:

1. Housing: Low-copper cast-aluminum alloy, complying with NEMA 250, Type 4.
2. Terminals: Six or eight as required by sensor.
3. Conduit Connection: 1/2-inch trade size.
4. Sensor Connection: NPS 1/2.

- D. Assembly: Sensor manufacturer shall furnish sensor, thermowell, and sensor connection head to provide a matched assembly.

## 2.7 LIQUID TEMPERATURE SWITCHES

### A. Thermostat and Switch for Temperature Control in Pipe Applications:

- 1. Description:
  - a. Two-position control.
  - b. Field-adjustable set point.
  - c. Manual reset.
  - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 2. Performance:
  - a. Operating Temperature Range: 65 to 200 deg F.
  - b. Temperature Differential Deadband: 5 to 30 deg F, adjustable.
  - c. Enclosure Ambient Temperature: 150 deg F.
  - d. Sensing Element Pressure Rating: 200 psig.
  - e. Voltage: 120-V ac.
  - f. Current: 8 FLA.
  - g. Switch Type: SPDT snap switch.
- 3. Construction:
  - a. Vapor-Filled Immersion Element: Copper, nominal 3 inches long.
  - b. Temperature Scale: Fahrenheit, visible on face.
  - c. Set-Point Adjustment: Screw.
  - d. Enclosure: Painted metal, NEMA 250, Type 1.
  - e. Electrical Connections: Screw terminals.
  - f. Conduit Connection: 3/4-inch.

## 2.8 LIQUID AND STEAM TEMPERATURE TRANSMITTERS, COMMERCIAL GRADE

- A. House electronics in NEMA 250, enclosure.
- B. Enclosure Connection: 1/2-inch trade size.
- C. Functional Characteristics:
  - 1. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, wire sensors.
  - 2. Default Span (Adjustable):
    - a. Chilled Water: Zero to 100 deg F.
    - b. Condenser Water: Zero to 120 deg F.
    - c. Heating Hot Water: 32 to 212 deg F.

- d. Heat Recovery: Zero to 120 deg F.
  - 3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
  - 4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
  - 5. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.
- D. Performance Characteristics:
- 1. Calibration Accuracy: Within 0.1 percent of the span.
  - 2. Stability: Within 0.2 percent of the span for at least 6 months.
  - 3. Combined Accuracy: Within 0.5 percent.

### PART 3 - EXECUTION

#### 3.1 TEMPERATURE INSTRUMENT APPLICATIONS

- A. Air Temperature Sensors:
  - 1. Duct,; .
  - 2. Outdoor,; .
  - 3. Space,; .
- B. Air Temperature Transmitters:
  - 1. Duct,; .
  - 2. Outdoor,; .
  - 3. Space,; .
- C. Liquid and Steam Temperature Sensors:
  - 1. System,; .
- D. Liquid and Temperature Transmitters:
  - 1. System,; .

#### 3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- E. Corrosive Environments:
1. Use products that are suitable for environment to which they are subjected.
  2. If possible, avoid or limit use of materials in corrosive environments.
  3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
  4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.3 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.4 TEMPERATURE INSTRUMENT INSTALLATIONS

- A. Mounting Location:
  1. Roughing In:
    - a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
    - b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
      - 1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
      - 2) Do not begin installation without submittal approval of mounting location.



- c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.
2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
  3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
  4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
  5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- B. Special Mounting Requirements:
1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of .
  2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.
- C. Mounting Height:
1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
  2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
    - a. Make every effort to mount at 60 inches.
- D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- E. Space Temperature Sensor Installation:
1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
  2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
  3. In finished areas, recess electrical box within wall.
  4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.

5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.
- F. Outdoor Air Temperature Sensor Installation:
1. Mount sensor in a discrete location facing north.
  2. Protect installed sensor from solar radiation and other influences that could impact performance.
  3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.
- G. Single-Point Duct Temperature Sensor Installation:
1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.
  2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
  3. Rigidly support sensor to duct and seal penetration airtight.
  4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.
- H. Averaging Duct Temperature Sensor Installation:
1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.
  2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
  3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
  4. If required to have transmitter, mount transmitter in an accessible and serviceable location.
- I. Low-Limit Air Temperature Switch Installation:
1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
  2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
  3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
  4. Install on entering side of cooling coil unless otherwise indicated on Drawings.
- J. Liquid Temperature Sensor Installation:
1. Assembly shall include sensor, thermowell.
  2. For pipe NPS 4 and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.

3. For pipe smaller than NPS 4:
  - a. Install reducers to increase pipe size to NPS 4 at point of thermowell installation.
  - b. For pipe sizes NPS 2-1/2 and NPS 3, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
  - c. Minimum insertion depth shall be 2-1/2 inches.
4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

### 3.6 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

### 3.7 CHECK-OUT PROCEDURES

- A. Check installed products before continuity tests, leak tests, and calibration.
- B. Check temperature instruments for proper location and accessibility.
- C. Verify sensing element type and proper material.
- D. Verify location and length.
- E. Verify that wiring is correct and secure.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Perform according to manufacturer's written instruction.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Occupancy Adjustments: When requested within months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

END OF SECTION 230923.27

## SECTION 232300 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty.

B. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: .

#### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
1. Suction Lines for Air-Conditioning Applications: 300 psig.
  2. Suction Lines for Heat-Pump Applications: 535 psig.
  3. Hot-Gas and Liquid Lines: 535 psig.

### 2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: **ASTM B 88, Type K or L.**
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  2. End Connections: Socket ends.
  3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
  4. Working Pressure Rating: Factory test at minimum 500 psig.
  5. Maximum Operating Temperature: 250 deg F.

### 2.3 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
  2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
  3. Operator: Rising stem and hand wheel.
  4. Seat: Nylon.
  5. End Connections: Socket, union, or flanged.
  6. Working Pressure Rating: 500 psig.
  7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
  2. Packing: Molded stem, back seating, and replaceable under pressure.

3. Operator: Rising stem.
  4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
  5. Seal Cap: Forged-brass or valox hex cap.
  6. End Connections: Socket, union, threaded, or flanged.
  7. Working Pressure Rating: 500 psig.
  8. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
  2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
  3. Piston: Removable polytetrafluoroethylene seat.
  4. Closing Spring: Stainless steel.
  5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
  6. End Connections: Socket, union, threaded, or flanged.
  7. Maximum Opening Pressure: 0.50 psig.
  8. Working Pressure Rating: 500 psig.
  9. Maximum Operating Temperature: 275 deg F.
- D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
  2. Core: Removable ball-type check valve with stainless-steel spring.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Copper spring.
  5. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Body and Bonnet: Plated steel.
  2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and -V ac coil.
  6. Working Pressure Rating: 400 psig.
  7. Maximum Operating Temperature: 240 deg F.
- F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
  2. Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Working Pressure Rating: 400 psig.
  6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
  2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Packing and Gaskets: Non-asbestos.
  4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  5. Suction Temperature: .

6. Superheat: .
  7. Reverse-flow option (for heat-pump applications).
  8. End Connections: Socket, flare, or threaded union.
  9. Working Pressure Rating: .
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
  2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Packing and Gaskets: Non-asbestos.
  4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  5. Seat: Polytetrafluoroethylene.
  6. Equalizer: .
  7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and -V ac coil.
  8. End Connections: Socket.
  9. Set Pressure: .
  10. Throttling Range: Maximum 5 psig.
  11. Working Pressure Rating: 500 psig.
  12. Maximum Operating Temperature: 240 deg F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
  2. Screen: 100-mesh stainless steel.
  3. End Connections: Socket or flare.
  4. Working Pressure Rating: 500 psig.
  5. Maximum Operating Temperature: 275 deg F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
  2. Drain Plug: Brass hex plug.
  3. Screen: 100-mesh monel.
  4. End Connections: Socket or flare.
  5. Working Pressure Rating: 500 psig.
  6. Maximum Operating Temperature: 275 deg F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
  2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
  3. Indicator: Color coded to show moisture content in parts per million (ppm).
  4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
  5. End Connections: Socket or flare.
  6. Working Pressure Rating: 500 psig.
  7. Maximum Operating Temperature: 240 deg F.
- L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
  2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
  3. Desiccant Media: Activated .
  4. Designed for reverse flow (for heat-pump applications).



5. End Connections: Socket.
  6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
  7. Maximum Pressure Loss: **2 psig**.
  8. Rated Flow: .
  9. Working Pressure Rating: 500 psig.
  10. Maximum Operating Temperature: 240 deg F.
- M. Permanent Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell.
  2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
  3. Desiccant Media: Activated **alumina**.
  4. Designed for reverse flow (for heat-pump applications).
  5. End Connections: Socket.
  6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
  7. Maximum Pressure Loss: **2 psig**.
  8. Rated Flow: .
  9. Working Pressure Rating: 500 psig.
  10. Maximum Operating Temperature: 240 deg F.

## 2.4 REFRIGERANTS

- A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with **brazed or soldered** joints.
- B. Hot-Gas and Liquid Lines: Copper, **Type L**, annealed- or drawn-temper tubing and wrought-copper fittings with **brazed or soldered** joints.
- C. Hot-Gas and Liquid Lines, **and Suction Lines for Heat-Pump Applications**: Copper, **Type K**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- D. Hot-Gas and Liquid Lines, **and Suction Lines for Heat-Pump Applications**: Copper, **Type K**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- E. Safety-Relief-Valve Discharge Piping: Copper, **Type K**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, **Type K**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

### 3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install **diaphragm packless** valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
  - 1. Solenoid valves.
  - 2. Hot-gas bypass valves.
  - 3. Compressor.
- J. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- K. Install receivers sized to accommodate pump-down charge.
- L. Install flexible connectors at compressors.

### 3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

### 3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints according to AWS's "Braze Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BA9 (cadmium-free silver) alloy for joining copper with bronze or steel.

### 3.5 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
  - 1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
  - 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
  - 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
  - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
  - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
  - 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
  - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.

8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod, 1/2 inch.

D. Support multifloor vertical runs at least at each floor.

### 3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
  - a. Fill system with nitrogen to the required test pressure.
  - b. System shall maintain test pressure at the manifold gage throughout duration of test.
  - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
  - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

### 3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

### 3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
  2. Verify that compressor oil level is correct.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves except bypass valves that are used for other purposes.
  5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

## SECTION 233113 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Seismic-restraint devices.

##### B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
  2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
  3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
  - 2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
  - 3. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
  - 4. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
  - 5. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings:
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Factory- and shop-fabricated ducts and fittings.
  - 3. Duct layout indicating sizes, configuration, and static-pressure classes.
  - 4. Elevation of top of ducts.
  - 5. Dimensions of main duct runs from building grid lines.
  - 6. Fittings.
  - 7. Reinforcement and spacing.
  - 8. Seam and joint construction.
  - 9. Penetrations through fire-rated and other partitions.
  - 10. Equipment installation based on equipment being used on Project.
  - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- D. Delegated-Design Submittal:
  - 1. Sheet metal thicknesses.
  - 2. Joint and seam construction and sealing.
  - 3. Reinforcement details and spacing.
  - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
  - 5. Design Calculations: Calculations for selecting hangers and supports.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:



1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.

B. Welding certificates.

#### 1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

### PART 2 - PRODUCTS

#### 2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than **60 Inches** in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: **G60**.
  2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

#### 2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  2. Tape Width: **3 inches**.
  3. Sealant: Modified styrene acrylic.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  7. Service: Indoor and outdoor.
  8. Service Temperature: Minus 40 to plus 200 deg F.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
  10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m) and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.6 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by .
  - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least times the maximum seismic forces to which they will be subjected.
- B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- C. Restraint Cables: -steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- D. Hanger Rod Stiffener: to hanger rod.
- E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

### 3.2 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Exhaust Ducts: Seal Class C.
  - 4. Outdoor, Return-Air Ducts: Seal Class C.
  - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
  - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with
  1. Space lateral supports a maximum of **40 feet** o.c., and longitudinal supports a maximum of **80 feet** o.c.
  2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.

- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by .
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 DUCT CLEANING

- A. Clean duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
  - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
  - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
  - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.



2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.7 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

### 3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
  1. Underground Ducts: Concrete-encased,.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
  - a. Pressure Class: Positive **1-inch wg.**
  - b. Minimum SMACNA Seal Class: **C**.
  - c. SMACNA Leakage Class for Rectangular: **12** .
  - d. SMACNA Leakage Class for Round and Flat Oval: **12** .

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
  - a. Pressure Class: Positive or negative **1-inch wg.**
  - b. Minimum SMACNA Seal Class: **C**.
  - c. SMACNA Leakage Class for Rectangular: **12** .
  - d. SMACNA Leakage Class for Round and Flat Oval: **12** .

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative **1-inch wg.**
  - b. Minimum SMACNA Seal Class: **C** if negative pressure, and **A** if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: **12** .
  - d. SMACNA Leakage Class for Round and Flat Oval: **6** .

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
  - a. Pressure Class: Positive or negative **1-inch wg.**
  - b. Minimum SMACNA Seal Class: **C**.
  - c. SMACNA Leakage Class for Rectangular: **12** .
  - d. SMACNA Leakage Class for Round and Flat Oval: **6** .
2. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Positive or negative **2-inch wg.**
  - b. Minimum SMACNA Seal Class: **B**.
  - c. SMACNA Leakage Class for Rectangular: **6** .
  - d. SMACNA Leakage Class for Round and Flat Oval: **3** .

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: **Galvanized steel** .
2. Aluminum Ducts: **or galvanized sheet steel coated with zinc chromate.**

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
  - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
  - b. Round Elbows, **12 Inches** and Smaller in Diameter: Stamped or pleated.

- c. Round Elbows, **14 Inches** and Larger in Diameter: **Welded.**

H. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Spin in.
- 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm: Conical tap.
  - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

## SECTION 233300 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

##### B. Related Requirements:

1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
3. Section 283112 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

##### B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

##### C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
- b. Manual volume damper installations.
- c. Control-damper installations.
- d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
- e. Wiring Diagrams: For power, signal, and control wiring.

### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

### 2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  1. Galvanized Coating Designation: **G60**.
  2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Description: Gravity balanced.

- B. Maximum Air Velocity: **1000 fpm.**
- C. Maximum System Pressure: **2-inch wg.**
- D. Frame: Hat-shaped, **0.05-inch-thick, galvanized sheet steel** , with welded corners or mechanically attached.
- E. Blades: Multiple single-piece blades, **end pivoted**, maximum 6-inch width, **0.025-inch-thick, roll-formed aluminum** with sealed edges.
- F. Blade Action: Parallel.
- G. Blade Seals: **Neoprene, mechanically locked.**
- H. Blade Axles:
  - 1. Material: .
  - 2. Diameter: .
- I. Tie Bars and Brackets: .
- J. Return Spring: Adjustable tension.
- K. Bearings: **Steel ball** .
- L. Accessories:
  - 1. Adjustment device to permit setting for varying differential static pressure.
  - 2. Counterweights and spring-assist kits for vertical airflow installations.
  - 3. Electric actuators.
  - 4. Chain pulls.
  - 5. Screen Mounting: Front mounted in sleeve.
    - a. Sleeve Thickness: 20 gage minimum.
    - b. Sleeve Length: 6 inches minimum.
  - 6. Screen Mounting: Rear mounted.
  - 7. Screen Material: **Galvanized steel.**
  - 8. Screen Type: **Bird.**
  - 9. 90-degree stops.

## 2.4 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Standard leakage rating.
  - 2. Suitable for horizontal or vertical applications.
  - 3. Frames:
    - a. Frame: Hat-shaped, **0.094-inch-thick, galvanized sheet steel.**
    - b. Mitered and welded corners.

- c. Flanges for attaching to walls and flangeless frames for installing in ducts.
  4. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. **Galvanized** -steel, 0.064 inch thick.
  5. Blade Axles: **Galvanized steel** .
  6. Bearings:
    - a. **Oil-impregnated bronze** .
    - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  7. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:
1. Standard leakage rating.
  2. Suitable for horizontal or vertical applications.
  3. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
  4. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
    - e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
  5. Blade Axles: .
  6. Bearings:
    - a. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  7. Tie Bars and Brackets: Aluminum.
- C. Jackshaft:
1. Size: **0.5-inch** diameter.
  2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
  3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- D. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
  2. Include center hole to suit damper operating-rod size.



3. Include elevated platform for insulated duct mounting.

## 2.5 CONTROL DAMPERS

### A. Frames:

1. **Hat** shaped.
2. **0.094-inch-thick, galvanized sheet steel.**
3. corners.

### B. Blades:

1. Multiple blade with maximum blade width of .
2. -blade design.
3. .
4. Blade Edging: **Closed-cell neoprene.**
5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

### C. Blade Axles: 1/2-inch-diameter; **galvanized steel** ; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

### D. Bearings:

1. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
2. Thrust bearings at each end of every blade.

## 2.6 FLANGE CONNECTORS

### A. Description: , factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

### B. Material: Galvanized steel.

### C. Gage and Shape: Match connecting ductwork.

## 2.7 TURNING VANES

### A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

### B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: wall.

## 2.8 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
  - 1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - 3. Number of Hinges and Locks:
    - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    - b. Access Doors up to Square: and two sash locks.
    - c. Access Doors up to 24 by 48 Inches: and two compression latches.
    - d. Access Doors Larger Than 24 by 48 Inches: and two compression latches with outside and inside handles.
- B. Pressure Relief Access Door:
  - 1. Door and Frame Material: Galvanized sheet steel.
  - 2. Door: with metal thickness applicable for duct pressure class.
  - 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
  - 4. Factory set at .
  - 5. Doors close when pressures are within set-point range.
  - 6. Hinge: Continuous piano.
  - 7. Latches: Cam.
  - 8. Seal: Neoprene or foam rubber.
  - 9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

## 2.9 DUCT ACCESS PANEL ASSEMBLIES

- A. Labeled according to UL 1978 by an NRTL.
- B. Panel and Frame: Minimum thickness **0.0528-inch carbon** steel.
- C. Fasteners: **Carbon** steel. Panel fasteners shall not penetrate duct wall.

- D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- E. Minimum Pressure Rating: 10-inch wg, positive or negative.

## 2.10 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd..
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd..
  - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F.

## 2.11 FLEXIBLE DUCTS

- A. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 10 to plus 160 deg F.
- B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; **polyethylene** vapor-barrier film.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 210 deg F.
  - 4. Insulation R-value: .
- C. Flexible Duct Connectors:

1. Clamps: **Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action** in sizes 3 through 18 inches, to suit duct size.
2. Non-Clamp Connectors: **Adhesive** .

## 2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install **backdraft** dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  1. Install steel volume dampers in steel ducts.
  2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  1. On both sides of duct coils.
  2. Upstream from duct filters.
  3. At outdoor-air intakes and mixed-air plenums.
  4. At drain pans and seals.

5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  7. At each change in direction and at maximum 50-foot spacing.
  8. Upstream from turning vanes.
  9. Upstream or downstream from duct silencers.
  10. Control devices requiring inspection.
  11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
  2. Two-Hand Access: 12 by 6 inches.
  3. Head and Hand Access: 18 by 10 inches.
  4. Head and Shoulders Access: 21 by 14 inches.
  5. Body Access: 25 by 14 inches.
  6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. Connect terminal units to supply ducts **directly or** with maximum **12-inch** lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers or light troffer boots to ducts with maximum **60-inch** lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with **adhesive** .
- P. Install duct test holes where required for testing and balancing purposes.
- 3.2 FIELD QUALITY CONTROL
- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
  2. Inspect locations of access doors and verify that purpose of access door can be performed.
  3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  4. Inspect turning vanes for proper and secure installation.

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END OF SECTION 233300

## SECTION 233416 - CENTRIFUGAL HVAC FANS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: For each product.
  - 1. Backward-inclined centrifugal fans.
  - 2. Forward-curved centrifugal fans.

#### 1.2 ACTION SUBMITTALS

- A. Product Data:
  - 1. Include rated capacities, furnished specialties, and accessories for each fan.
  - 2. Certified fan performance curves with system operating conditions indicated.
  - 3. Certified fan sound-power ratings.
  - 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 5. Material thickness and finishes, including color charts.
  - 6. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Belts: **One** set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AMCA Compliance: Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

B. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

C. Backward-Inclined Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

D. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.



3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

## 2.3 FORWARD-CURVED CENTRIFUGAL FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

B. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

C. Forward-Curved Wheels:

1. Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

D. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

#### 2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
  1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in
  2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
  3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction.

- F. Unit Support: Install centrifugal fans level on structural . Coordinate wall penetrations and flashing with wall construction.
- G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install and vibration isolation and seismic-control devices.
  - 1. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
  - 2. Comply with requirements in for vibration isolation devices.
- H. Install units with clearances for service and maintenance.
- I. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Adjust belt tension.
  - 6. Adjust damper linkages for proper damper operation.
  - 7. Verify lubrication for bearings and other moving parts.
  - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  - 9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
  - 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

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C. Prepare test and inspection reports.

END OF SECTION 233416

## SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers..
2. Linear slot diffusers.
3. Fixed face **registers** .

B. Related Sections:

1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified.

### PART 2 - PRODUCTS

#### 2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: .
3. Finish: .
4. Face Size: .
5. Face Style: .
6. Mounting: .
7. Pattern: .
8. Dampers: .
9. Accessories:
  - a. Equalizing grid.

- b. Plaster ring.
- c. Safety chain.
- d. Wire guard.
- e. Sectorizing baffles.
- f. Operating rod extension.

## 2.2 CEILING LINEAR SLOT OUTLETS

### A. Linear Slot Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material - Shell: **Steel, insulated.**
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: .
5. Finish - Pattern Controller: .
6. Finish - Tees: , **color selected by Architect.**
7. Slot Width: .
8. Number of Slots: **Two** .
9. Length: **24 inches.**
10. Accessories: .

## 2.3 REGISTERS AND GRILLES

### A. Fixed Face Register:

1. Material: .
2. Finish: , **color selected by Architect.**
3. Face Arrangement: **1/2-by-1/2-by-1/2-inch grid** core.
4. Core Construction: **Integral.**
5. Frame: **1 inch** wide.
6. Mounting Frame: .
7. Mounting: .
8. Damper Type: .
9. Accessory: Filter.

## 2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.

- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713



## SECTION 235523.16 - HIGH-INTENSITY, GAS-FIRED, RADIANT HEATERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. High-intensity, infrared, gas-fired, radiant heaters.
2. Gas-fired, outdoor, infrared patio heaters.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power wiring.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

#### 1.5 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Period: All warranty periods listed below are from date of Substantial Completion.
  - a. Ceramic Tiles: years.
  - b. Heater Components: year(s).

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with .
  - 1. CSA certified, with CSA Seal and certification number clearly visible on units.
  - 2. UL listed and labeled, with UL label clearly visible on units.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.2 HIGH-INTENSITY, INFRARED, GAS-FIRED, RADIANT HEATERS

- A. Factory-assembled, **indoor**, overhead-mounted, electrically controlled, high-intensity, infrared, radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.
- B. Fuel Type: Design burner for **natural** gas having characteristics same as those of gas available at Project site.
- C. Burner Assembly: Modular, **aluminized steel with powder-coat or similar finish** plenum chamber secured with stainless-steel retainers.
- D. Emitter: Perforated ceramic tiles.
- E. Reflector: One-sided, bright-polished aluminum.
- F. Ignition:
  - 1. Manual Pilot: Self-energizing with no external power connection.
  - 2. Direct Spark: -V ac, solid-state ignition module with spark electrode and flame sensor.
- G. Accessories:
  - 1. Wire grid or expanded metal secondary emitter for increased efficiency.
  - 2. Protective screen and heat-deflector shield.
  - 3. Stainless-steel flexible connector with manual valve for gas supply.
  - 4. Hanger chain with "S" hooks.
  - 5. Preassembled chain suspension kit.
  - 6. Rigid mounting kits.
  - 7. Clearance warning plaque.
  - 8. Thermostat

### 2.3 GAS-FIRED, OUTDOOR, INFRARED PATIO HEATERS

- A. Factory-assembled, , overhead-mounted, electrically controlled, high-intensity, infrared, radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

- B. Fuel Type: Design burner for gas having characteristics same as those of gas available at Project site.
- C. Burner Assembly: Modular, plenum chamber secured with stainless-steel retainers.
- D. Emitter: Perforated ceramic tiles.
- E. Reflector: **Polished stainless steel.**
- F. Ignition: Direct spark, **115/120-V** ac, solid-state ignition module with spark electrode and flame sensor.
- G. Accessories:
  - 1. Wire grid or expanded metal secondary emitter for increased efficiency.
  - 2. Protective screen and heat-deflector shield.
  - 3. Stainless-steel flexible connector with manual valve for gas supply.
  - 4. Hanger chain with "S" hooks.
  - 5. Preassembled chain suspension kit.
  - 6. Rigid mounting kits.
  - 7. Clearance warning plaque.
- H. Capacities and Characteristics:
  - 1. Gas Input: .
  - 2. Gas Output: .
  - 3. Electrical Characteristics:
    - a. Volts: .
    - b. Phase: Single.
    - c. Hertz: 60.
    - d. Full-Load Amperes: .
    - e. Minimum Circuit Ampacity: .
    - f. Maximum Overcurrent Protection: .

## 2.4 CONTROLS AND SAFETIES

- A. Failure Safeguards: 100 percent main gas shutoff on **pilot or power** failure.
- B. Thermostat: Devices and wiring are specified in Section 230923.27 "Temperature Instruments."
- C. Thermostat: Single-stage, wall-mounted type with 50 to 90 deg F operating range and fan on switch.
  - 1. Control Transformer: Integrally mounted.
- D. Thermostat: Two-stage, wall-mounted type with 50 to 90 deg F operating range and fan on switch.
  - 1. Control Transformer: Integrally mounted.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to **NFPA 54**.
- B. Suspended Units: **Suspend from substrate using chain hanger kits and building attachments.**
  - 1. Restrain the unit to resist seismic acceleration. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
  - 2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- C. Maintain manufacturers' recommended clearances for combustibles.
- D. Gas Piping: Comply with **Section 231123 "Facility Natural-Gas Piping."** Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
  - 1. Gas Connections: Connect gas piping to radiant heaters according to **NFPA 54**.
- E. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.
- F. Electrical Connections: Comply with applicable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  - 1. Install electrical devices furnished with heaters but not specified to be factory mounted.
- G. Adjust initial-temperature set points.
- H. Adjust burner and other unit components for optimum heating performance and efficiency.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 2. Verify bearing lubrication.
  - 3. Verify proper motor rotation.
  - 4. Test Reports: Prepare a written report to record the following:
    - a. Test procedures used.
    - b. Test results that comply with requirements.
    - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

- B. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 235523.16

## SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes packaged, air-cooled, refrigerant compressor and condenser units.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

#### 1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Compressor failure.
    - b. Condenser coil leak.
  - 2. Warranty Period: **Five** years from date of Substantial Completion.
  - 3. Warranty Period (Compressor Only): **Five** years from date of Substantial Completion.
  - 4. Warranty Period (Components Other Than Compressor): **Five** years from date of Substantial Completion.
  - 5. Warranty Period (Condenser Coil Only): **Five** years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS

- A. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.
- B. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
  - 1. Motor: **Two** speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - 2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
  - 3. Accumulator: Suction tube.
- C. Refrigerant: **R-410A**.
- D. Refrigerant: R-407C or R-410A.
- E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.
- F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection.
- G. Accessories:
  - 1. Coastal Filter: Mesh screen to protect condenser coil from salt damage.
  - 2. Crankcase heater.
  - 3. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
  - 4. **Low-voltage thermostat and subbase** to control compressor and condenser unit and evaporator fan.
  - 5. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
  - 6. Filter-dryer.
  - 7. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
  - 8. Liquid-line solenoid.
  - 9. Low-Ambient Controller: Cycles condenser fan to permit operation down to **0 deg F**.
  - 10. Low-Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F.
  - 11. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
  - 12. PE mounting base.
  - 13. Precharged and insulated suction and liquid tubing.
  - 14. Sound Hood: Wraps around sound attenuation cover for compressor.
  - 15. Thermostatic expansion valve.
  - 16. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
  - 17. Reversing valve.

- H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.
- I. Capacities and Characteristics:
  - 1. Compressor and Condenser Unit:
    - a. Energy-Efficiency Ratio (EER): .
    - b. Coefficient of Performance (COP) with 17°F ambient temperature: .
  - 2. Electrical Characteristics:
    - a. Kilowatt Input: .
    - b. Volts: .
    - c. Phase: .
    - d. Hertz: .

## 2.2 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS

- A. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.
- B. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.
  - 1. Capacity Control: **Hot-gas bypass**.
- C. Refrigerant: **R-410A** .
- D. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.
- E. Condenser Fan: Propeller-type vertical discharge; either directly or belt driven. Include the following:
  - 1. Permanently lubricated, ball-bearing motors.
  - 2. Separate motor for each fan.
  - 3. Dynamically and statically balanced fan assemblies.
- F. Operating and safety controls include the following:
  - 1. Manual-reset, high-pressure cutout switches.
  - 2. Automatic-reset, low-pressure cutout switches.
  - 3. Low-oil-pressure cutout switch.
  - 4. Compressor-winding thermostat cutout switch.
  - 5. Three-leg, compressor-overload protection.
  - 6. Control transformer.
  - 7. Magnetic contactors for compressor and condenser fan motors.
  - 8. Timer to prevent excessive compressor cycling.



G. Accessories:

1. to control compressor and condenser unit and evaporator fan.
2. Low-Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F.
3. Low-Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F.
4. Gage Panel: Package with refrigerant circuit suction and discharge gages.
5. Hot-gas bypass kit.
6. Part-winding-start timing relay, circuit breakers, and contactors.
7. Reversing valve.

H. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
5. Condenser coil **hail guard**.

I. Capacities and Characteristics:

1. Compressor and Condenser Unit:
  - a. Full-Load Cooling Capacity: .
  - b. Energy-Efficiency Ratio (EER): .
  - c. Coefficient of Performance (COP) with 17°F ambient temperature: .
2. Refrigerant Connections:
  - a. Liquid Pipe Size: .
  - b. Suction Pipe Size: .
3. Compressors:
  - a. Number of Compressors: .
  - b. Rated-Load Amperes: .
  - c. Locked-Rotor Amperes: .
  - d. Power Input: .
4. Air-Cooled Condenser:
  - a. Ambient-Air Temperature: .
  - b. Airflow: .
  - c. Number of Condenser Fans: .
  - d. Condenser Fan Motor Size: .
5. Electrical Characteristics:

- a. Volts: .
- b. Phase: .
- c. Hertz: .

### 2.3 SOURCE QUALITY CONTROL

- A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."
- B. Testing Requirements: Factory test sound-power-level ratings according to .

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated.
- B. Install roof-mounting units on equipment supports specified in Section 077200 "Roof Accessories."
- C. Equipment Mounting:
  - 1. Install compressor and condenser units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in **Section 033000 "Cast-in-Place Concrete."**
  - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

### 3.2 CONNECTIONS

- A. Comply with requirements for piping in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Section 15179 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- C. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
  - 2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 5. Verify proper airflow over coils.
- C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

END OF SECTION 236200

## SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
  - 2. Product Data for Prerequisite EA 3: Documentation indicating that refrigerants comply.
  - 3. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
  - 4. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
  - 5. Product Data for Credit IEQ 1: Documentation indicating that units are equipped with a direct outdoor airflow-measuring device capable of measuring the minimum outdoor airflow with accuracy within 15 percent of the design minimum airflow rate, as defined by ASHRAE 62.1.
  - 6. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
  - 7. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
  - 8. Product Data for Credit IEQ 5: Documentation indicating that units include MERV 13 filters rated according to ASHRAE 52.2.
- C. Shop Drawings: Include plans, elevations, sections, and attachment details.
- D. Delegated-Design Submittal: For design of , including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof-curb mounting details, drawn to scale, and coordinated with each other, using input from installers of the items involved:

- B. Seismic Qualification Certificates: For dedicated outdoor-air units, accessories, and components, from manufacturer.
- C. Startup service reports.
- D. Sample warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: years from date of Substantial Completion.
  - 2. Warranty Period for Heat Exchangers: years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

#### 2.2 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design **vibration isolation** .
- C. Seismic Performance: Units shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
- D. Cabinet Thermal Performance:
  - 1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
  - 2. Maximum Overall U-Value: **0.10 Btu/h x sq. ft. x deg F**.
  - 3. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- E. Cabinet Surface Condensation:
  - 1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.

2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.
- F. Maximum Cabinet Leakage: percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.
- G. Cabinet Deflection Performance:
1. Walls and roof deflection shall be within **1/200** of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
  2. Floor deflections shall be within **1/240** of the span considering the worst-case condition caused by the following:
    - a. Service personnel.
    - b. Internal components.
    - c. Design working pressure defined for the walls and roof.
- H. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.3 CABINET

- A. Construction: **double** wall.
- B. Exterior Casing Material: **Galvanized steel with paint finish or stainless steel.**
- C. Interior Casing Material: **Galvanized or stainless** steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- F. Cabinet Insulation:
1. Type: **Fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.**
  2. Thickness: **1 inch.**
  3. Insulation Adhesive: Comply with ASTM C 916, Type I.
  4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
- G. Condensate Drain Pans:

1. Shape: Rectangular, with **1** percent slope in at least two planes to direct water toward drain connection.
  2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
    - a. Length: Extend drain pan downstream from leaving face **to comply with ASHRAE 62.1.**
    - b. Depth: A minimum of **2 inches** deep.
  3. Configuration: Single wall.
  4. Configuration: Double wall, with space between walls filled with foam insulation and moisture-tight seal.
  5. Material: Galvanized-steel sheet with asphaltic waterproofing compound coating on pan top surface.
  6. Material: Stainless-steel sheet.
  7. Drain Connection:
    - a. Located on of pan, at lowest point of pan.
    - b. Terminated with threaded nipple.
    - c. Minimum Connection Size: **NPS 1.**
  8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- H. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

## 2.4 SUPPLY FAN

- A. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.
1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
  2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
  3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
  4. Fan Enclosure: Easily removable enclosure around rotating parts.
  5. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.
- B. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum **1.4** service factor.
- C. Motors:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  2. Enclosure: **Totally enclosed.**
  3. Enclosure Materials: .
  4. Motor Bearings: .
  5. Unusual Service Conditions:

- a. Ambient Temperature: .
  - b. Altitude: above sea level.
  - c. High humidity.
6. Efficiency: Premium efficient.
  7. NEMA Design: .
  8. Service Factor: .
- D. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with isolators.

## 2.5 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410.
- B. Coil Casing Material: **Manufacturer's standard material** .
- C. Tube Material: **Copper**.
- D. Tube Header Material: **Manufacturer's standard material** .
- E. Fin Material: **Aluminum** .
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Capacity Reduction: Circuit coils for **face** control.
- I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- J. Coating: Phenolic epoxy corrosion-protection coating after assembly.

## 2.6 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: **Scroll** compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.
- D. Refrigerant: **R-410A** .
  1. Classified as Safety Group A1 according to ASHRAE 34.
  2. Provide unit with operating charge of refrigerant.
- E. Refrigeration System Specialties:
  1. Expansion valve with replaceable thermostatic element.



2. Refrigerant dryer.
3. High-pressure switch.
4. Low-pressure switch.
5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
6. Brass service valves installed in discharge and liquid lines.

F. Capacity Control:

1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
2. Patented, Rawal APR control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
3. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
4. Heat-pipe heat exchanger wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.

G. Refrigerant **condenser and reheat condenser** coils:

1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410.
2. Tube Material: Copper.
3. Fin Material: **Aluminum**.
4. Fin and Tube Joint: Mechanical bond.
5. Leak Test: Coils shall be leak tested with air underwater.
6. Coating: Phenolic epoxy corrosion-protection coating after assembly.

H. Condenser Fan Assembly:

1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
2. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - b. Motor Enclosure: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure.
  - c. Unusual Service Conditions:
    - 1) High humidity.
  - d. Built-in overcurrent and thermal-overload protection.
  - e. Efficiency: Premium efficient.
  - f. Service Factor: .
3. Fan Safety Guards: Steel with corrosion-resistant coating.

I. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

## 2.7 ELECTRIC-RESISTANCE HEATING COIL

- A. UL Compliance: Comply with requirements in UL 1995, "Heating and Cooling Equipment."
- B. Electric-Resistance Heating Elements:
  - 1. Coiled Resistance Wire: 80 percent nickel and 20 percent chromium.
  - 2. Tubular-Steel Sheath: Compacted magnesium oxide powder.
  - 3. Fins: Spiral-wound, copper-plated, steel fins continuously brazed to sheath.
  - 4. Heating Capacity: Low density 35 W per sq. in., factory wired for single-point wiring connection; with time delay for element staging and overcurrent- and overheat-protection devices.
  - 5. Safety Controls:
    - a. Blower-motor interlock, air-pressure switch.
    - b. Quiet mercury contactors.
    - c. Time delay between steps.
    - d. Integral, nonfused power disconnect switch.
- C. Electric-Resistance Heating Elements:
  - 1. Open-Coil Resistance Wire: 80 percent nickel and 20 percent chromium.
  - 2. Supports and Insulation: Floating ceramic bushings recessed into casing openings; fastened to supporting brackets and mounted in galvanized-steel frame.
  - 3. Heating Capacity: Low density 35 W per sq. in., factory wired for single-point wiring connection; with time delay for element staging and overcurrent- and overheat-protection devices.
  - 4. Safety Controls:
    - a. Blower-motor interlock, air-pressure switch.
    - b. Quiet mercury contactors.
    - c. Time delay between steps.
    - d. Integral, nonfused power disconnect switch.

## 2.8 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

## 2.9 FILTERS

- A. Cleanable Filters: 2-inch-thick, cleanable metal mesh.
- B. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, viscous-coated, flat-panel type.
3. Thickness: **1 inch**.
4. Initial Resistance: .
5. Recommended Final Resistance: .
6. Minimum Arrestance: **80**, according to ASHRAE 52.1.
7. Minimum Merv: **6**, according to ASHRAE 52.2.
8. Media: Interlaced glass fibers sprayed with nonflammable adhesive.

C. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, dry, extended-surface type.
3. Thickness: **1 inch**.
4. Initial Resistance: .
5. Recommended Final Resistance: .
6. Minimum Arrestance: **90**, according to ASHRAE 52.1.
7. Minimum Merv: **7**, according to ASHRAE 52.2.
8. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.

D. Extended-Surface, Nonsupported-Media Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, dry, extended-surface, self-supporting type.
3. Initial Resistance: .
4. Recommended Final Resistance: .
5. Minimum Arrestance: **95**, according to ASHRAE 52.1.
6. Minimum Merv: **13**, according to ASHRAE 52.2.
7. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.

E. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Extended surface filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

## 2.10 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a field power connection to unit.
- B. Enclosure: NEMA 250, **Type 4X**, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.

- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to **NEMA KS 1, heavy-duty, nonfused disconnect switch**.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
  - 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
  - 2. NEMA KS 1, heavy-duty, nonfusible switch.
  - 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Lights: Factory wire unit-mounted lights.
- K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.
- L. Control Relays: Auxiliary and adjustable time-delay relays.

## 2.11 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Control Valves: Comply with requirements in Section 230923.11 "Control Valves."
- C. Control Wiring: Factory wire connection for controls' power supply.
- D. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- E. **Remote** -Mounted Status Panel:
  - 1. Cooling/Off/Heating Controls: Control operational mode.
  - 2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
  - 3. Status Lights:
    - a. Filter dirty.
    - b. Fan operating.
    - c. Cooling operating.

- d. Heating operating.
  - e. Smoke alarm.
  - f. General alarm.
4. Digital Numeric Display:
- a. Outdoor airflow.
  - b. Supply airflow.
  - c. Outdoor dry-bulb temperature.
  - d. Outdoor dew point temperature.
  - e. Space temperature.
  - f. Supply temperature.
  - g. Space relative humidity.
  - h. Space carbon dioxide level.
- F. Control Dampers:
1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service.
  2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.
  3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
  4. Damper Label: Bear the AMCA seal for both air leakage and performance.
  5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
  6. Damper Frame Material: **Extruded aluminum galvanized steel or stainless steel.**
  7. Blade Type: **hollow-shaped airfoil.**
  8. Blade Material: **Extruded aluminum galvanized steel or stainless steel.**
  9. Maximum Blade Width: 6 inches.
  10. Maximum Blade Length: 48 inches.
  11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
  12. Bearings: Thrust bearings for vertical blade axles.
  13. Airflow Measurement:
    - a. Monitoring System: Complete and functioning system of airflow monitoring as an integral part of the damper assembly where indicated.
    - b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
    - c. Accuracy of flow measurement: Within **10** percent of the actual flow rate between the range of the scheduled minimum and maximum airflow. For units with a large range between minimum and maximum airflow, configure the damper sections and flow measurement assembly as necessary to comply with accuracy.
    - d. Straightening Device: Integral to the flow measurement assembly if required to achieve the specified accuracy as installed.
    - e. flow measuring device: Suitable for operation in untreated and unfiltered outdoor air. If necessary, include temperature and altitude compensation and correction to maintain the accuracy.
- G. Damper Operators:

1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
  2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
  3. Maximum Operating Time: Open or close damper 90 degrees in **60** seconds.
  4. Adjustable Stops: For both maximum and minimum positions.
  5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
  6. Spring-return operator to fail-safe; either closed or open as required by application.
  7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.
  8. Position feedback Signal: For remote monitoring of damper position.
  9. Coupling: V-bolt and V-shaped, toothed cradle.
  10. Circuitry: Electronic overload or digital rotation-sensing circuitry.
- H. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Links shall include the following:
1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
  2. Hardware interface or additional sensors for the following:
    - a. Room temperature.
    - b. Discharge-air temperature.
    - c. Refrigeration system operating.
- I. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.
1. **ASHRAE 135 (BACnet)** communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.
- 2.12 ACCESSORIES
- A. Service Lights and Switch: Factory installed in with weatherproof cover. Factory wire lights to a single-point field connection.
  - B. Duplex Receptacle: Factory mounted in unit supply-fan section, with 20 amp 120 V GFI duplex receptacle and weatherproof cover.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Equipment Mounting:
  - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in
- D. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- E. Install 3000-psi, compressive-strength (28-day) concrete base inside roof curb, thick. Concrete and reinforcement are specified with concrete.
- F. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."
- G. Install separate devices furnished by manufacturer and not factory installed.
- H. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- I. Install drain pipes from unit drain pans to sanitary drain.
  - 1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L, with soldered joints.
  - 2. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
    - a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
  - 3. Pipe Size: Same size as condensate drain pan connection.

### 3.2 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

C. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.3 STARTUP SERVICE

A. **Engage a factory-authorized service representative to perform** startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
3. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
  - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
  - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
  - c. Condenser coil entering-air dry-bulb temperature.
  - d. Condenser coil leaving-air dry-bulb temperature.
4. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
5. Inspect casing insulation for integrity, moisture content, and adhesion.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean coils and inspect for construction debris.
10. Verify bearing lubrication.
11. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Adjust fan belts to proper alignment and tension.
13. Start unit.
14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
15. Operate unit for run-in period.
16. Calibrate controls.
17. Adjust and inspect high-temperature limits.
18. Verify operational sequence of controls.



19. Measure and record the following airflows. Plot fan volumes on fan curve.

- a. Supply-air volume.
- b. Return-air flow.
- c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

### 3.4 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 237433

## SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
  - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
  - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

- a. For Compressor: **Five** year(s) from date of Substantial Completion.
- b. For Parts: **Five** year(s) from date of Substantial Completion.
- c. For Labor: **One** year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

### 2.2 INDOOR UNITS (5 TONS OR LESS)

- A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
7. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Filters: Permanent, cleanable.
10. Condensate Drain Pans:
  - a. Fabricated with percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
    - 1) Length: Extend drain pan downstream from leaving face .
    - 2) Depth: A minimum of deep.
  - b. Double-wall, **stainless**-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
  - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on **one end** of pan.
  - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
  - e. Units with stacked coils shall have an intermediate drain pan to collect condensate

## 2.3 OUTDOOR UNITS (5 TONS OR LESS)

### A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant Charge: .
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

## 2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
  - 1. Compressor time delay.
  - 2. 24-hour time control of system stop and start.
  - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  - 4. Fan-speed selection including auto setting.
- D. Automatic-reset timer to prevent rapid cycling of compressor.
- E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- F. Drain Hose: For condensate.
- G. Additional Monitoring:
  - 1. Monitor constant and variable motor loads.
  - 2. Monitor variable-frequency-drive operation.
  - 3. Monitor economizer cycle.
  - 4. Monitor cooling load.
  - 5. Monitor air distribution static pressure and ventilation air volumes.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
  - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in
  - 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
  - 3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

### 3.4 DEMONSTRATION

- A. Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

## SECTION 238416 - MECHANICAL DEHUMIDIFICATION UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes packaged, factory-assembled and -tested, refrigerant-type, mechanical dehumidification units designed for **indoor** installation.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Dehumidification units shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each dehumidification unit indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
  - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5, "Systems and Equipment."
- C. Shop Drawings: For each dehumidification unit indicated. Include plans, elevations, sections, details, and attachments to other work.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For accessories, and components, from manufacturer.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and Startup."
  - 2. Applicable requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dehumidification units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than     years from date of Substantial Completion.
  - 2. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than     years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

### 2.2 CASINGS

- A. Casing: -wall construction with corrosion-protective coating and exterior     finish, stainless-steel fasteners.
  - 1. Access: **Removable panels** with neoprene gaskets.
  - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Drain Pan and Connection: **Plastic; insulated and complying with ASHRAE 62.1.**

### 2.3 FANS

- A. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."



## 2.4 FILTERS

- A. Glass Fiber: Minimum **80** percent arrestance according to ASHRAE 52.1, and **MERV 5** according to ASHRAE 52.2.
- B. Pleated: Minimum **90** percent arrestance according to ASHRAE 52.1, and **MERV 7** according to ASHRAE 52.2.

## 2.5 REFRIGERATION SYSTEM

- A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1.
- B. Refrigerant Coils: Copper tubes; factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits and **stainless**-steel frame. Coil and fins shall have a polyester coating.
- C. Compressors: Hermetic, scroll type with integral vibration isolators and crankcase heaters.
  - 1. Number of Refrigerant Circuits: Two for compressor capacities more than 7-1/2 tons.
  - 2. Refrigerant: **R-410A**.
  - 3. Refrigerant: R-134a, R-407C, or R-410A.
  - 4. Capacity Control:
  - 5. Compressor Motor Overload Protection: Manual reset.
  - 6. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.

## 2.6 CONTROLS

- A. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and in Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Operating Control: Space humidistat cycles the compressor. Humidistat shall incorporate fan on-off-auto switch.
- C. Operating Controls: Factory-installed microprocessor controller.
  - 1. Display the following on the face of controller:
    - a. System on.
    - b. System dehumidifying mode.
    - c. System air-conditioning mode.
    - d. System outdoor-air (economizer) mode.
    - e. System heating pool water.
    - f. Auxiliary space heat is operating.
    - g. Unit requires service.
    - h. Return-air (space) temperature.
    - i. Return-air (space) humidity.
    - j. Pool-water temperature.

- k. Outdoor-air temperature.
2. Indicate the following sensor failures on panel:
    - a. Airflow: Dirty air filter, blocked airflow, and fan failure.
    - b. Refrigerant high and low pressure.
    - c. High water temperature.
    - d. High and low evaporator temperature.
    - e. Low water flow.
    - f. Communication fault.
    - g. System off.
    - h. Antishort cycle delay.
    - i. Power failure.
  3. Provide access to the following set points on panel:
    - a. Space temperature.
    - b. Space relative humidity.
    - c. Outdoor ventilation/air-conditioning changeover temperature.
    - d. Airflow alarm.
  4. Provide the following displays on panel:
    - a. Space temperature.
    - b. Space relative humidity.
    - c. Outdoor-air temperature.
    - d. Supply-air temperature.
    - e. Return-air temperature.
    - f. Airflow rating.
    - g. Air-off evaporator temperature.
    - h. Return-air relative humidity.
    - i. Service codes.
  5. Provide the following controls on panel:
    - a. System on-off, fan continues to run.
    - b. Fan on-off.
    - c. Service code access.
    - d. System dehumidifying mode.
    - e. System air-conditioning mode.
    - f. System outdoor-air (economizer) mode.
    - g. Auxiliary space heat is operating.
    - h. Outdoor-air-temperature, conditioned-space-temperature, and control set-point-temperature digital display.
    - i. Outdoor enthalpy digital display.
    - j. Filter pressure drop digital display.
    - k. Status: Airflow, fans, system, unit operation, and operating mode.
    - l. Alarm digital display.

## 2.7 ACCESSORIES

- A. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.
  - 1. Operating Voltage: 24-V dc, nominal.
  - 2. Self-restoring.
  - 3. Plug-in arrangement.
  - 4. Integral visual-indicating light.
  - 5. Sensitivity: Can be tested and adjusted in-place after installation.
  - 6. Integral addressable module.
  - 7. Sensor: Digital display or infrared light source with matching silicon-cell receiver.
  - 8. Detector Sensitivity: Between 2.5 and 3.5 percent/foot of smoke obscuration when tested according to UL 268A.
  - 9. Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.
- B. Electrical Convenience Outlet: 115-V ac fused, duplex.

## 2.8 CAPACITIES AND CHARACTERISTICS

- A. Refrigeration System:
  - 1. Dehumidification Capacity: .

## 2.9 SOURCE QUALITY CONTROL

- A. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.
- B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to ARI 575.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Equipment Mounting:
  - 1. Install dehumidification units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in
  - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
  - 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.
- C. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.

- D. Connect condensate drain pans using minimum NPS 1-1/4 copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.
- E. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.
- F. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Section 15179 "Hydronic Piping Specialties." Connect to supply coil tappings with shutoff valve, return coil tappings with balancing valve, and union or flange at each connection.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
  - 2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Dehumidification unit will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.3 STARTUP SERVICE

- A. Perform the following final checks before startup:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
  - 4. Set outside- and return-air mixing dampers to minimum outside-air setting.
  - 5. Install clean filters.
  - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for dehumidification units include the following:
  - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
  - 2. Measure and record motor's electrical values for voltage and amperage.

3. Manually operate dampers from fully closed to fully open position and record fan performance.
- C. Adjust damper linkages for proper damper operation.
- D. Adjust initial temperature and humidity set points.

END OF SECTION 238416

***DIVISION 26***

***ELECTRICAL***

## SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Basic Electrical Requirements specifically applicable to Division 26 Sections, in addition to Division 1 General Requirements.

#### 1.2 SCOPE

- A. This scope covers the furnishing, installation, testing, adjusting and placing in operation all electrical equipment, devices, facilities, materials, and auxiliary items necessary for the complete and successful operation of all electrical equipment as herein described, shown on the plans, or deemed necessary for the completion of the electrical portion of the project. It is the intent of DIVISION 26 to outline the electrical requirements of the contract in order to provide the information necessary for the construction of a fully operational system as shown on the plans and as herein described. A comprehensive electrical scope of work is as follows:
  1. Power/Electrical System
  2. Generator Systems
  3. Lighting System
  4. Utility Work
  5. Connection of Electrically Powered Mechanical Equipment
  6. Temporary Construction Power
  7. All Incidentals Necessary for a Complete and Fully Operational Electrical System.

#### 1.3 WORKING CLEARANCES

- A. Working clearances around equipment requiring electrical services shall be verified by Contractor to comply with Code requirements. Should there be apparent violations of clearances; the Contractor shall notify the Engineer before proceeding with connection or placing of equipment.
- B. In the case of panelboards, safety switches and other equipment requiring wire and cable terminations, the Contractor shall ascertain that lug sizes and wiring gutters, or space allowed for proper accommodation and termination of the wires and cables are adequate.

#### 1.4 WORKMANSHIP

- A. Workmanship under this Division shall be accomplished by persons skilled in the performance of the required task. All work shall be done in keeping with conventions

of the trade. Work of this Division shall be closely coordinated with work of other trades to avoid conflict and interference.

#### 1.5 PROTECTION OF ELECTRICAL EQUIPMENT

- A. Electrical equipment shall be protected by the weather, especially from water dripping or splashing upon it, always during shipment, storage and after installation. Should any apparatus be subjected to possible injury by water, it shall be thoroughly dried out and put through a dielectric test, at the expense of the contractor, to ascertain the suitability of this apparatus. The results of the test shall be submitted to the Engineer and if the apparatus is found to be unsuitable, the contractor shall replace it without additional cost to the Owner.

#### 1.6 UTILITIES

- A. The electrical contractor shall install a fully operational electrical service as described in the plans.
- B. Arrange with the utility company for the services and install the services in accordance with their requirements, regulations and recommendations.

#### 1.7 GUARANTEE

- A. Contractor shall guarantee all light bulbs. They shall be guaranteed for a period of one (1) year after the building is occupied. Guarantee shall include material and labor for repair.
- B. The Contractor shall guarantee all other electrical systems, materials and workmanship to be free from defects for a period of one (1) year from the date of final acceptance. He shall correct all defects arising within this period upon notification by the Owner or Engineer, without additional compensation.
- C. It is understood that the rights and benefits given the Owner by the guarantees found in the technical specifications are in addition to and not in derogation of any rights or benefits found in the special and general provisions of the contract.

#### 1.8 TEMPORARY POWER AND LIGHTS DURING CONSTRUCTION

- A. It shall always be the responsibility of the Contractor to provide and maintain adequate temporary power and lighting during construction, so that the various other trades can accomplish their work in a flawless manner. Particular attention will be given to power and lighting for masonry, drywall, painting, tile work and any other finish work.



1.9 MATERIAL STANDARDS

- A. Material shall be new and comply with standards of Underwriters' Laboratories, Inc., where standards have been established for the particular product and the various NEMA, ANSI, ASTM, IEEE, AEIC, IPCEA or other publications referenced.

1.10 TEST EQUIPMENT

- A. The contractor shall provide all test equipment and supplies deemed necessary by the Engineer at no extra cost to the Owner. These supplies shall include but not be limited to the following: volt meters, amp meters, clamp-on ground rod test meter, light meters, generator load banks & temporary cables, watt meters, harmonic distortion test equipment, thermal image camera, megger tester, high pot test equipment, power quality analyzers, recording power meter, and oscilloscopes.

1.11 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code.
- B. ANSIC2 – National Electrical Safety Code.
- C. NEMA – National Electrical Manufacturer's Assoc.
- D. UL – Underwriters Laboratories
- E. NFPA – National Fire Protection Assoc.
- F. IEEE – The Institute of Electrical and Electronics Engineers
- G. IESNA – The Illuminating Engineering Society of North America
- H. NETA – International Electrical Testing Association
- I. API – American Petroleum Institute
- J. AGA – American Gas Association
- K. Recommended Standards for Water Works and Wastewater Facilities as published by Great Lakes – Upper Mississippi River Board of State Public Health and Environmental Managers.

1.12 SUBMITTAL

- A. Submit under provisions of the General Provisions.
  - 1. The Contractor installing all Electrical work shall review and approve all electrical shop drawings prior to submittal to the Engineer for review. As part of the review, the installer shall certify the following:
    - a. I hereby certify that the (equipment) (material) (article) shown and marked in this submittal is in compliance with the contract drawing and

specifications, can be installed in the allocated space, will be stored in accordance with the manufacturers recommendation, will be installed per NEC, and is submitted for approval.

Certified by: \_\_\_\_\_ Date: \_\_\_\_\_

- B. Submit shop drawings and product data grouped to include complete submittal of related systems, products, and accessories in a single submittal. No electrical work may be performed until shop drawings are approved. Submit Shop Drawings on the Following Systems as Grouped Below:
1. High Voltage Distribution System
    - a. Transformers
    - b. Switches
    - c. Distribution Equipment
    - d. High Voltage Cable
    - e. Equipment Pads
    - f. Utility Conduit
    - g. Miscellaneous Materials
    - h. Utility Work
  2. Low Voltage Power/Electrical System
    - a. Conduit and Conduit Fittings
    - b. Wire
    - c. Pull Boxes
    - d. Panelboards
    - e. Panelboard Layouts
    - f. Circuit Breakers
    - g. Disconnects
    - h. Fuses
    - i. Conduit Support Systems
    - j. Wiring Devices
    - k. Switchboards
    - l. Transformers
    - m. Surge Protection Equipment
    - n. Breaker Coordination Study
  3. Generator Equipment
    - a. Generator
    - b. Fuel System
    - c. Generator Paralleling/ATS Equipment
    - d. Generator Enclosure
    - e. Power Correction Equipment
  4. Lighting System
    - a. All Light Fixtures
      - 1) Computer Printout of Lighting Layout
      - 2) Sample Fixture (as directed by Engineer)
      - 3) IES Photometric Files
    - b. Poles & Foundations
  5. Miscellaneous Electrical Equipment
    - a. Miscellaneous Electrical Parts
  6. Drawings
    - a. Coordination drawing of All Electrical Room
    - b. Conduit layout drawings

- c. Duct drawings
- d. As-Built Drawings

C. Mark dimensions and values in units to match those specified.

#### 1.13 REGULATORY REQUIREMENTS

- 1. Conform to applicable sections of the Building Code and all local rules, regulations and ordinances.
- 2. Electrical: Conform to NFPA 70 & National Electric Safety Code
- 3. Obtain permits, and request inspections from authority having jurisdiction.
- 4. References listed in Paragraph 1.11, this section.

#### 1.14 FINAL INSPECTION AND TESTING

- A. After the electrical installation is complete, the Contractor shall deliver to the Engineer the following information with his request for final inspection.
  - 1. One set of contract drawings marked to show all significant changes in equipment ratings and locations, alterations in locations of conduit runs, or of any data differing from the contract drawings. This shall include revised or changed panelboard and switchgear schedules.
  - 2. Certificates of final inspection from local authority.
  - 3. A tabulation of all motors listing their respective manufacturer, horsepower, nameplate voltage and current, actual running current after installation and overload heater rating.
- B. The electrical work shall be thoroughly tested to demonstrate that the entire system is in proper working order and in accordance with the plans and specifications. Each motor with its control shall be run as nearly as possible under operating conditions for a sufficient length of time to demonstrate correct alignment, wiring capacity, speed and satisfactory operation. All main switches and circuit breakers shall be operated, but not necessarily at full load. Contractor may be required during final inspection, at the request of the Engineer to furnish test instruments for use during the testing.
- C. All wiring shall be given a megger test using a 1000 Volt megger. This test shall be performed after conductors are pulled, but before final connections are made. The Engineer shall be given two (2) days' written notice of the anticipated test date so that he may witness the test if so desired. In any event, the Contractor shall record the circuit designation and the megger reading on each phase. This written record shall be submitted to the Engineer. The cost of this test or any retest caused by insufficient megger readings shall be the responsibility of the Contractor (All tests shall be done in accordance with NETA Standards).

#### 1.15 STAFFING

- A. The electrical contractor shall provide a Certified Electrical Contractor through the State, as the Electrical Superintendent for the project. The Electrical Superintendent shall be on the project site any time any electrical work is performed by the contractor.

- B. In addition, the contractor shall provide one electrician classified as Journeyman for every four electrical helpers used on the project site.

#### 1.16 AS-BUILT DRAWINGS

- A. The contractor shall provide detailed as-built drawings for the project indicating all power wiring.
- B. The As-Built drawings shall include detailed drawings of all duct banks, underground conduit, above ground conduit, motor control centers, PLC control panels, control drawings. These drawings shall indicate exact location of all underground electrical wiring and fiber optic cable.
  - 1. The location shall indicate the following
    - a. Centerline location
    - b. Width / Cross section
    - c. Depth
- C. The Engineer will provide electronic copies of all drawings in the bid plans set on a CD for use by the contractor.

END OF SECTION 26500

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. For definitions of grounding and bonding terms see NFPA 70.

#### 1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
  - 1. Underground distribution grounding.
  - 2. Ground bonding common with lightning protection system.
  - 3. Foundation steel electrodes.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
  - 1. Test wells.
  - 2. Ground rods.
  - 3. Ground rings.
  - 4. Grounding arrangements and connections for separately derived systems.
- B. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section "Operation and Maintenance Data," include the following:

- a. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on NETA MTS
  - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
  - 2) Include recommended testing intervals.

## 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Burndy; Part of Hubbell Electrical Systems.
  - 2. ERICO International Corporation.
  - 3. Harger Lightning and Grounding.
  - 4. ILSCO.
  - 5. O-Z/Gedney; A Brand of the EGS Electrical Group.
  - 6. Robbins Lightning, Inc.
  - 7. Siemens Power Transmission & Distribution, Inc
  - 8. Or Engineer approved equal

### 2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
  2. Stranded Conductors: ASTM B 8.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.
- D. Grounding & Bonding Conductors
1. All raceways and equipment shall be provided with an Equipment Grounding Conductor as shown on the drawings. When the Equipment Grounding Conductor is not shown on the drawings, provide an Equipment Grounding Conductor per Table 250.122 of the NEC
  2. All Service Entrance Equipment shall be provided with a Grounding Electrode Conductor between the Service Entrance Ground and the Grounding Electrode System as shown on the drawings. When the Grounding Electrode Conductor is not shown on the drawing, provide a Grounding Electrode Conductor per Table 250.66 of the NEC.
  3. Main Bonding Jumper installed between the Service Entrance Ground and Neutral and shall be sized per Table 250.66 of the NEC.
  4. System Bonding Jumper installed between the Separately Derived System Ground and Neutral and shall be sized per Table 250.66 of the NEC.

## 2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

## 2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet (19 mm by 3 m) min
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
  1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.

2. Backfill Material: Electrode manufacturers recommended material.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
  1. Bury at least 24 inches (600 mm) below grade.
  2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
  2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
  1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  3. Connections to Ground Rods at Test Wells: Bolted connectors.
  4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

### 3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.



### 3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, no shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors' level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

### 3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Ant frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters

enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

- F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- G. Metallic Fences: Comply with requirements of IEEE C2.
  - 1. Grounding Conductor: Bare copper, not less than No. 8AWG.
  - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
  - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

### 3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. When service grounding is not detailed on the drawings,, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
  - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of area.

1. Install copper conductor not less than No. 2/0 AWG or as shown on the drawing for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

### 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81 and NETA Standards.
  4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: **5**ohms.
  2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
  3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: **3** ohms.
  4. Power Distribution Units or Panelboards Serving Electronic Equipment: **3** ohm(s).
  5. Substations and Pad-Mounted Equipment: **5** ohms.
  6. Manhole Grounds: **10** ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
  - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.
  - 3. Nonmetallic slotted channel systems. Include Product Data for components.
  - 4. Equipment supports.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

## 1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

## 1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof mounted electrical with structural and architectural specification and drawings.

## PART 2 - PRODUCTS

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Allied Tube & Conduit.

- b. Cooper B-Line, Inc.
  - c. ERICO International Corporation.
  - d. GS Metals Corp.
  - e. Thomas & Betts Corporation.
  - f. Unistrut; Atkore International.
  - g. Wesanco, Inc.
  - h. or Approved Equal
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  4. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) on center, in at least 1 surface.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.
    - c. Fabco Plastics Wholesale Limited.
    - d. Seasafe, Inc.
    - e. or Approved Equal
  2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
  3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
  4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices shall be as indicated below:
1. PVC Conduit – PVC, Fiberglass, or Stainless Steel (unless atmosphere is corrosive to Stainless Steel)
  2. RGS Conduit – Galvanized Steel
  3. Aluminum Conduit – Stainless Steel
  4. PVC Coated RGS – Stainless Steel (unless atmosphere is corrosive to Stainless Steel); if atmosphere is corrosive to Stainless Steel then use Fiberglass
  5. EMT – Painted or Galvanized Steel
  - 6.
- E. Cable Tray Supports shall be as indicated below:
1. Galvanized Steel – Galvanized or Stainless Steel
  2. Fiberglass – Stainless Steel or a combination of Fiberglass and Stainless Steel
  3. Aluminum – Stainless Steel

- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Hilti, Inc.
      - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.
      - 5) or Approved Equal
  2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Cooper B-Line, Inc.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti, Inc.
      - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
      - 6) or Approved Equal
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  6. Toggle Bolts: All-steel springhead type.
  7. Hanger Rods: Threaded steel.



## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps].

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb. (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

7. To Light Steel: Sheet metal screws.
  8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements as specified in the contract documents.
- C. Anchor equipment to concrete base.
  1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

- B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

#### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, include those for internal components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- C. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Allied Tube & Conduit.
  - 3. Anamet Electrical, Inc.
  - 4. Electri-Flex Company.
  - 5. O-Z/Gedney.
  - 6. Picoma Industries.
  - 7. Republic Conduit.
  - 8. Robroy Industries.
  - 9. Southwire Company.
  - 10. Thomas & Betts Corporation.
  - 11. Western Tube and Conduit Corporation.
  - 12. Wheatland Tube Company.
  - 13. or Approved Equal.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: compression.
  - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Anamet Electrical, Inc.
  - 3. Arnco Corporation.
  - 4. CANTEX Inc.
  - 5. CertainTeed Corporation.
  - 6. Condux International, Inc.
  - 7. Electri-Flex Company.
  - 8. Kraloy.
  - 9. Carlon Electrical Products.

10. Niedax-Kleinhuis USA, Inc.
  11. RACO; Hubbell.
  12. Thomas & Betts Corporation.
  13. or Approved Equal.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, or EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. Rigid HDPE: Comply with UL 651A.
- G. Continuous HDPE: Comply with UL 651B.
- H. Coilable HDPE: Preassembled with conductors or cables and complying with ASTM D 3485.
- I. RTRC: Comply with UL 1684A and NEMA TC 14.
- J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- K. Fittings for LFNC: Comply with UL 514B.

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
  2. Hoffman.
  3. Mono-Systems, Inc.
  4. Square D.
  5. or Approved Equal.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 for interior or Type 4X stainless steel for exterior unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type for NEMA 1 and hinged, flanged-and-gasketed type for NEMA 4X unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

#### 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Moulded Products, Inc.
  - 2. Hoffman.
  - 3. Carlon Electrical Products.
  - 4. Niedax-Kleinhuis USA, Inc.
  - 5. or Approved Equal.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: Fiberglass polyester or PVC, extruded and fabricated to required size and shape, and having hinged cover with captive screws.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

#### 2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with Snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Mono-Systems, Inc.
    - b. Panduit Corp.
    - c. Wiremold / Legrand.
    - d. or Approved Equal.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from

manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Incorporated.
  - b. Mono-Systems, Inc.
  - c. Panduit Corp.
  - d. Wiremold / Legrand.
  - e. or Approved Equal.

D. Tele-Power Poles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Mono-Systems, Inc.
  - b. Panduit Corp.
  - c. Wiremold / Legrand.
  - d. or Approved Equal.
2. Material: Galvanized steel with baked-enamel finish in Architect choice of colors.
3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Adalet.
  2. Cooper Technologies Company; Cooper Crouse-Hinds.
  3. EGS/Appleton Electric.
  4. Erickson Electrical Equipment Company.
  5. FSR Inc.
  6. Hoffman.
  7. Hubbell Incorporated.
  8. Kraloy.
  9. Milbank Manufacturing Co.
  10. Mono-Systems, Inc.
  11. O-Z/Gedney.
  12. RACO; Hubbell.
  13. Robroy Industries.
  14. Spring City Electrical Manufacturing Company.
  15. Stahlin Non-Metallic Enclosures.
  16. Thomas & Betts Corporation.
  17. Wiremold / Legrand.
  18. or Approved Equal.



- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum to match raceway type, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
  - 1. Material: sheet metal.
  - 2. Type: Fully adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, round.
  - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover, unless otherwise noted.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep), unless otherwise noted.
- N. Gangable boxes are prohibited, unless specifically noted.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4X Stainless Steel for outdoor locations, Type 12 for indoor locations, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

P. Cabinets:

1. NEMA 250, Type 4X Stainless Steel for outdoor locations, Type 12 for indoor locations, with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Armorcast Products Company.
  - b. Carson Industries LLC.
  - c. NewBasis.
  - d. Oldcastle Precast, Inc.
  - e. Quazite: Hubbell Power System, Inc.
  - f. Synertech Moulded Products.
  - g. Or approved equal.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, as required to identify system indicated on the drawings.

7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass unless otherwise noted.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. NewBasis.
    - d. Nordic Fiberglass, Inc.
    - e. Oldcastle Precast, Inc; Christy Concrete Products.
    - f. Quazite: Hubbell Power System, Inc; Hubbell Power Systems.
    - g. Synertech Moulded Products.
    - h. Or Approved Equal.
  2. Standard: Comply with SCTE 77.
  3. Color of Frame and Cover: Gray.
  4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  7. Cover Legend: Molded lettering, as required to identify system indicated on the drawings
  8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
  2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: ARC.
  2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC, unless otherwise indicated on drawings.
  3. Underground Conduit: RNC, Type EPC-40-PVC when concrete encased, Type EPC-80-PVC when direct buried,
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC unless otherwise indicated on drawings
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X Stainless steel unless otherwise indicated on drawings.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed, Not Subject to Severe Physical Damage: EMT.
  3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Gymnasiums.
  4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  6. Damp or Wet Locations: GRC unless otherwise noted.
  7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4X stainless steel in institutional and commercial kitchens and damp or wet locations, unless otherwise noted.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- 
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
  - F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
  - G. Install surface raceways only where indicated on Drawings.
  - H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C) .

### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Raceways Embedded in Slabs:
  1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
  2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  3. Arrange raceways to keep a minimum of 3 inches of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
- J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Surface Raceways:
1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
  2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground raceway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- V. Expansion-Joint Fittings:
  - 1. Provide expansion joint fitting any time conduit systems cross building expansion joints or structural expansion joints.
  - 2. Provide expansion fittings as recommended by the manufacturer of the conduit.
  - 3. Provide expansion fittings per NFPA 70.
  - 4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
  - 3. Provide a separate ground for all flex conduits.
- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between boxes and cover plate or supported equipment and box.
- Z. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- AA. Locate boxes so that cover or plate will not span different building finishes.
- BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

- DD. Set metal floor boxes level and flush with finished floor surface.
- EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit.
2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction per 95% modified proctor density.
3. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor. Wrap conduit with 2 coats of 3M Scotch Wrap or Approved Equal.
  - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
4. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### 3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping." If Section 078413 is not included as part of the project specifications, provide fire rated penetrations based on the fire proofing material being supplied. All penetrations through fire rated walls shall be fire proofed.



3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Direct-buried conduit, ducts, and duct accessories.
  - 2. Concrete-encased conduit, ducts, and duct accessories.
  - 3. Handholes and boxes.
  - 4. Manholes.

1.3 DEFINITIONS

- A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include duct-bank materials, including separators and miscellaneous components.
  - 2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Include accessories for manholes, handholes, and boxes.
  - 4. Include warning tape.
- B. Shop Drawings:
  - 1. Precast manholes and handholes:
    - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
    - b. Include duct entry provisions, including locations and duct sizes.
    - c. Include reinforcement details.
    - d. Include frame and cover design and manhole frame support rings.
    - e. Include Step details.

- f. Include grounding details.
- g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
- h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
- b. Include duct entry provisions, including locations and duct sizes.
- c. Include cover design.
- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
  - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Engineer and Owner's written permission.

- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted in the contract documents.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

### 2.2 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

### 2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ARNCO Corp.
  - 2. Beck Manufacturing.
  - 3. Cantex, Inc.
  - 4. CertainTeed Corporation.
  - 5. Condux International, Inc.
  - 6. ElecSys, Inc.
  - 7. Electri-Flex Company.
  - 8. IPEX Inc.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Spiraduct/AFC Cable Systems, Inc.
  - 11. or Approved Equal.
- B. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-80 (only when specifically called out on the drawings) and Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.
- C. Duct Accessories:
  - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
  - 2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

- 2.4 PRECAST CONCRETE HANDHOLES AND BOXES (All Handholes and Boxes larger than 4 sq. ft. shall be precast)
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Christy Concrete Products.
  2. Elmhurst-Chicago Stone Co.
  3. Oldcastle Precast Group.
  4. Rinker Group, Ltd.
  5. Riverton Concrete Products.
  6. Utility Concrete Products, LLC.
  7. Utility Vault Co.
  8. Wausau Tile Inc.
  9. or Approved Equal
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Top of handhole to be located 6" above finished grade (handhole cover is not traffic rated).
- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Galvanized steel frame, with hinged galvanized steel access door assembly with tamper-resistant, captive, cover-securing bolts.
    - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    - b. Cover Handle: Recessed.
  2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  3. Cover Legend: Molded lettering, as required to identify system indicated on the drawings.
  4. Configuration: Units shall be designed for raised burial and have open bottom unless otherwise indicated. (Install handholes on a minimum of 12" of clean crushed stone.)
  5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
    - a. Extension shall provide increased depth of 12 inches (300 mm).
    - b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
  6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
  7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

- a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
  - b. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie to concrete envelopes of duct banks.
  - c. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
8. Handholes shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE (for area less than 4 sq. ft.)

- A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
1. Color: Gray.
  2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated. (Install on 12" of clean crushed stone)
  3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
  4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  5. Cover Legend: Molded lettering, as required to identify system indicated on the drawing.
  6. All conduits shall enter the handholes and other boxes from the bottom. All 90-degree bends shall be long radius.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two. Boxes shall be rated for Tier 22 or Tier 15 based on location.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. NewBasis.
    - d. Quazite: Hubbell Power System, Inc.
    - e. or Approved Equal.

2.6 PRECAST MANHOLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Christy Concrete Products.
  2. Elmhurst-Chicago Stone Co.

3. Oldcastle Precast Group.
  4. Rinker Group, Ltd.
  5. Riverton Concrete Products.
  6. Utility Concrete Products, LLC.
  7. Utility Vault Co.
  8. Wausau Tile Inc.
  9. or Approved Equal
- B. Comply with ASTM C 858.
- C. Precast Manholes: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- D. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
1. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
  2. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
  3. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
- E. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
- F. Ground Rod Sleeve: Provide a 3-inch (75-mm) PVC conduit sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the ducts routed from the facility.
- G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- H. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (725 mm).
    - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
  2. Cover Legend: Cast in. Selected to suit system.

- a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
  - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
- a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
- I. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- J. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- K. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- L. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
- M. Cable Rack Assembly: hot-dip galvanized, except insulators.
1. Stanchions: T-section or channel; 2-1/4-inch (56-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
  2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (450 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
  3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- N. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- O. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater, Two required.



## 2.7 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

### 3.2 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables More than 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 -PVC, in concrete-encased duct bank unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- D. Underground Ducts Crossing Roadways and Paved Areas: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

### 3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
  - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
  - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 or Polymer concrete, SCTE 77, Tier 22 structural load rating.

3. Units in Sidewalk, Similar Applications, and Non-Paved Areas with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 or Polymer concrete units, SCTE 77, Tier 15

B. Manholes: Precast concrete.

1. H-20 structural load rating according to AASHTO HB 17.

### 3.4 EARTHWORK

- A. Excavation and Backfill: Comply with the provisions of the contract documents and the manufacturer's recommendations. Compact gravel under manholes and handholes to 95% modified proctor.

1. Provide 12" of crushed stone for placement of all manholes and handholes

- B. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

- C. Cut and patch existing pavement in the path of underground ducts and utility structures according to the general provisions of the contract. ."

### 3.5 DUCT INSTALLATION

- A. Install ducts according to NEMA TCB 2.

- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.

- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.

- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

- E. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

- F. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) over center for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
  2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch (19 mm).
  3. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- H. Building Conduit Entry Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- I. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in empty ducts.
- J. Concrete-Encased Ducts: Support ducts on duct separators.
1. Excavate trench bottom to provide firm and uniform support for duct bank.
  2. Width: Excavate trench 12 inches (300 mm) wider than duct bank on each side.
  3. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
  4. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
  5. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
  7. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
    - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.
    - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

8. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
10. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover at top and bottom, and a minimum of 2 inches (50 mm) on each side of duct bank.
11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
  - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
  - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (15-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
12. Pouring Concrete: Comply with requirements in accordance with the general conditions of the contract. Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

K. Direct-Buried Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct bank.
2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
3. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
4. Depth: Install top of duct bank at least 24" below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
7. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
  - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.
  - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment

pad or foundation. Install insulated grounding bushings on terminations at equipment.

8. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply to 95% modified Proctor.

- a. Place minimum 3 inches (75 mm) of sand as a bed for duct bank. Place sand to a minimum of 6 inches (150 mm) above top level of duct bank.

- L. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

### 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

#### A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

#### B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below frost line.
4. Traffic Rated Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Install precast handholes without traffic rated lids 6" above grade.
6. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
  - E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and precast concrete handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
  - F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
  - G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE
- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.
  - B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
  - C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
  - D. Install handholes and boxes with bottom below frost line.
  - E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
  - F. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
  - G. For enclosures subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with the provisions of the general contract. Finish with a trowel.
2. Dimensions: in accordance with the manufacturer's recommendations but no less than 10 inches wide by 12 inches deep.

### 3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Install a 10' x 3/4" copper clad steel ground rod in each manhole and handhole. Bond ground rod to grounding electrode in duct bank or duct counterpoise if provided. Bond ground rod to all metal parts inside the manhole or handhole.

### 3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
  1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
  2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- (150-mm-) long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
  3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

### 3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

SECTION 260554 – SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
  - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.
- B. Related Requirements:
  - 1. For penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items, use UL listed assemblies for the type and installation applied.

1.03 ACTION SUBMITTALS

- A. Submit in accordance with Section 01300:
  - 1. Product data: for each type of product

PART 2 – PRODUCTS

2.01 SLEEVES

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40. (For use with grounding electrode conductors only.)
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.



- F. Sleeves for Rectangular Openings:
  - 1. Material: Galvanized sheet steel.
  - 2. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## 2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. CALPICO, Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.
    - e. Proco Products, Inc.
    - f. or Approved Equal.
  - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3. Pressure Plates: Stainless steel.
  - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Presealed Systems.
    - b. or Approved Equal.

## 2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 – EXECUTION

### 3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07900 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- G. Underground, Exterior-Wall and Floor Penetrations: Install steel pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### 3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 16131

## SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  1. Identification for raceway and metal-clad cable.
  2. Identification for conductors and communication and control cable.
  3. Underground-line warning tape.
  4. Warning labels and signs.
  5. Instruction signs.
  6. Equipment identification labels.
  7. Miscellaneous identification products.

#### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1, ANSI C2, and ANSI Z635.4.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

#### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by

codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.
- E. Install all signs and labels horizontal (level) and consistent for similar equipment and panels.

## PART 2 - PRODUCTS

### 2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

### 2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

### 2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength: 50 lb., minimum.
  - 3. Temperature Range: Minus 40 to plus 185 deg F.
  - 4. Color: Black, except where used for color-coding.

- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with snap-around label.
  - 1. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands:
  - 1. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
  - 2. Fire Alarm System: Red.
  - 3. Fire-Suppression Supervisory and Control System: Red and yellow.
  - 4. Combined Fire Alarm and Security System: Red and blue.
  - 5. Security System: Blue and yellow.
  - 6. Mechanical and Electrical Supervisory System: Green and blue.
  - 7. Telecommunication System: Green and yellow.
  - 8. Control Wiring: Green and red.
- C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and hand holes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
  - 1. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
  - 1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- E. Conductor Color Code Identification: Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a given branch circuit shall be identified by color coded tape or cable insulation at all termination, connection or splice points.
- F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
  - 1. Write-On Tags: Polyester tag, 0.015-inch-thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
  4. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway. During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches above duct. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
1. Description:
    - a. Permanent, bright-colored, continuous-printed, polyethylene tape.
    - b. Not less than 6 inches wide by 4 mils thick.
    - c. Compounded for permanent direct-burial service.
    - d. Embedded continuous metallic strip or core.
    - e. Printed legend shall indicate type of underground line.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
  2. Comply with NFPA 70 and 29 CFR 1910.145.
  3. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
  4. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
  5. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
  6. Warning label and sign shall include, but are not limited to, the following legends:

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- a. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - b. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- J. Instruction Signs:
1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with ENGINEER/OWNER APPROVED instructions where needed for system or equipment operation. Instructions are needed for all equipment unless otherwise noted.
    - a. Signs shall be engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. in. and 1/8-inch-thick for larger sizes.
    - b. The engraved legend shall be ½ "White letters on Brown face and punched or drilled for mechanical fasteners.
    - c. The signs shall be installed with stainless hardware.
  2. Emergency Operating Instructions: Install emergency operating instruction signs at equipment used for power transfer, safety shutdown, or any other locations requiring operation in an emergency.
    - a. Signs shall be engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. in. and 1/8-inch-thick for larger sizes.
    - b. The engraved legend shall be ½ "White letters on Red face and punched or drilled for mechanical fasteners.
    - c. The signs shall be installed with stainless hardware.
- K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor and Outdoor Equipment: Use engraved, laminated acrylic or melamine labels, punched or drilled for screw mounting. Identification labels shall have white letters on a dark-gray background. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high. Mount labels with stainless hardware.
    - b. Elevated Components: Increase the size of the labels and letters to those appropriate for viewing from the floor.
  2. Equipment to Be Labeled:
    - a. Identification labeling of some items listed below may be required by individual Sections or by NFPA 70.
    - b. Panelboards, electrical cabinets, and enclosures.
    - c. Access doors and panels for concealed electrical items.
    - d. Electrical switchgear and switchboards.
    - e. Transformers.



- f. Electrical substations.
- g. Emergency system boxes and enclosures.
- h. Motor-control centers.
- i. Disconnect switches.
- j. Enclosed circuit breakers.
- k. Motor starters.
- l. Push-button stations.
- m. Power transfer equipment.
- n. Contactors.
- o. Battery inverter units.
- p. Battery racks.
- q. Power-generating units.
- r. Voice and data cable terminal equipment.
- s. Television/audio components, racks, and controls.
- t. Fire-alarm control panel and annunciators.
- u. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
- v. Monitoring and control equipment.
- w. Uninterruptible power supply equipment.
- x. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
- y. Control systems
- z. Field mounted control devices
- aa. Field mounted instruments

### 3.2 INSTALLATION PRACTICES

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- D. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
  - 1. Color shall be factory applied or, for sizes LARGER than No. 10 AWG if authorities having jurisdiction permit, field applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or

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taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

5. Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, the color codes used to identify each phase, neutral (if applicable) and ground conductor throughout the system shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment. Provide factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- E. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
  - F. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION 260553

## SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### SUMMARY

- B. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment. The study shall include the entire electrical system (both existing and proposed) for the facility.

#### 1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals Submit three signed and sealed reports and 1 complete electronic copy including all computer files.
  - 1. Arc-flash study input data, including completed computer program input data sheets.
  - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

- a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Professional Engineer
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E or CSA Z462-12(2012).

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- B. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

#### 1.6 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

### PART 2 - PRODUCTS

#### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. Operation Technology, Inc. (ETAP)
2. SKM Systems Analysis, Inc. (Power Tools for Windows)

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

## 2.2 SHORT-CIRCUIT STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. No AC Decrement (NACD) ratio.
  - e. Equivalent impedance.
  - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
  - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

- G. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

### 2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
  - 1. Location designation.
  - 2. Nominal voltage.
  - 3. Flash protection boundary.
  - 4. Hazard risk category.
  - 5. Incident energy.
  - 6. Working distance.
  - 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

### 3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
  - 1. The entire electrical system both new and old shall be included in the study.
- D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

- E. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, ac systems.
- F. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
  - 1. Electric utility's supply termination point.
  - 2. Switchgear.
  - 3. Unit substation primary and secondary terminals.
  - 4. Low-voltage switchgear.
  - 5. Motor-control centers.
  - 6. Standby generators and automatic transfer switches.
  - 7. Branch circuit panelboards.

### 3.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
  - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
  - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
  - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals. (Comply with NEC for selective coordination NFPA 70; 240.12, 700.27, 701.18)
- C. Transformer Primary Overcurrent Protective Devices:
  - 1. Device shall not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
    - a. Device tag.
    - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    - d. Fuse-current rating and type.
    - e. Ground-fault relay-pickup and time-delay settings.
  2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    - a. Device tag.
    - b. Voltage and current ratio for curves.
    - c. Three-phase and single-phase damage points for each transformer.
    - d. No damage, melting, and clearing curves for fuses.
    - e. Cable damage curves.
    - f. Transformer inrush points.
    - g. Maximum fault-current cutoff point.
- G. Provide completed data sheets for setting of overcurrent protective devices bound in a 3-ring binder.

### 3.4 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.
- C. Calculate maximum and minimum contributions of fault-current size.
1. The minimum calculation shall assume that the contribution from all sources is at a minimum and shall assume no motor load.
  2. The maximum calculation shall assume a maximum contribution from all sources and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.



- F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
  - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
  - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- G. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
  - 1. When the circuit breaker is in a separate enclosure.
  - 2. When the line terminals of the circuit breaker are separate from the work location.
- H. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

### 3.5 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
  - 1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
  - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
  - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study.
  - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  - 2. Obtain electrical power utility impedance at the service.
  - 3. Power sources and ties.
  - 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.

5. For reactors, provide manufacturer and model designation, voltage rating and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
9. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. Motor horsepower and NEMA MG 1 code letter designation.
11. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
12. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

### 3.6 LABELING

- A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
  1. Motor-control center.
  2. Low-voltage switchboard.
  3. Switchgear.
  4. Medium-voltage switch.
  5. Control panel.

### 3.7 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

### 3.8 DEMONSTRATION

- A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260574

## SECTION 16992 – COMMISSIONING OF ELECTRICAL SYSTEMS

### PART 1 – GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.02 SUMMARY

- A. Requirements for the CONTRACTOR to provide commissioning and installation services.
- B. Requirements for the CONTRACTOR to provide labor, materials, tools, and testing equipment to commission controls, networking, and communications related equipment and systems.
- C. Requirements for the CONTRACTOR to perform associated testing of electrical systems, wiring, equipment, and grounding.

#### 1.03 CITED STANDARDS

- A. National Fire Protection Association (NFPA):
  - 1. 70, National Electrical Code (NEC)
  - 2. 70E Standard for Electrical Safety in the Workplace 2012
- B. The Institute of Electrical and Electronics Engineers (IEEE)
- C. International Society of Automation (ISA)

#### 1.04 NOTED RESTRICTIONS

- A. Commissioning of any system shall not begin until permission is granted by the ENGINEER and OWNER.
- B. Comply with NFPA 70E.
- C. The OWNER shall have the option to witness and participate in the entire commissioning and integration process.

#### 1.05 QUALITY CONTROL

- A. The Integrator shall submit weekly and monthly commissioning progress reports to the ENGINEER. The report formats shall be developed by the Integrator.

- B. Test Equipment Traceability:
  - 1. The Integrator shall have a calibration program which maintains applicable test instrumentation and equipment within rated accuracy and within their calibration time limits.
  - 2. Equipment and instruments used to evaluate electrical performance shall be calibrated to a secondary standard traceable to the National Institute of Standards and Technology (NIST).
  - 3. Test equipment operating instructions and procedures shall be with the test equipment.
  - 4. A copy of test equipment calibration certificate or calibration sticker must be with equipment at all times to be available for inspection.

#### 1.06 SUBMITTALS

- A. The following submittals shall be made during commissioning:
  - 1. Progress reports
- B. A commissioning report shall be submitted upon the completion of commissioning activities to notify the OWNER and ENGINEER of the milestone and the readiness for Site Acceptance Testing (SAT). The commissioning report shall include, but not be limited to, the following:
  - 1. Completed commissioning checklists
  - 2. Completed punch lists
  - 3. Calibration data sheets
  - 4. Drawings and manuals
  - 5. Training

### PART 2 – PRODUCTS

#### 2.01 GENERAL

- A. Where equipment is to be retained but rewired that equipment and associated wiring shall be subjected to testing new equipment and wiring procedures.
- B. The start-up service personnel must follow job site electrical safety requirements, installation standards and electrical testing standards. Adhere to OSHA safety practices for the entirety of commissioning.
- C. OWNER designated representatives may witness all integrated system commissioning activities.
- D. In addition to the requirements of this section, the installation and commissioning will comply with all applicable requirements of the RFP.

#### 2.02 PRODUCT NAME

- A. A partial list of systems and equipment to be commissioned shall include but not limited to:
  - 1. Panel devices
  - 2. All modifications and associated devices
  - 3. PLC
  - 4. OIT
  - 5. Communication equipment
  - 6. Remote Access for pump station monitoring data
  - 7. Graphic Displays in OIT

### PART 3 – EXECUTION

#### 3.01 GENERAL

- A. The commissioning and installation shall be considered complete by the ENGINEER upon successful installation of control equipment and execution of the commissioning requirements listed herein. The Integrator shall be granted permission to begin the Site Acceptance Testing.
- B. CONTRACTOR shall be responsible for any damage to equipment or material due to improper testing or commissioning and shall replace or restore to original condition any damaged equipment or material.
- C. All systems, equipment, and rooms shall be commissioned in a complete manner as possible to ensure a complete working control system, network and communication system.
- D. The intent of commissioning is to start-up equipment or systems and prepare them for performance site acceptance testing. Care should be taken to ensure continuous and reliable operation of the booster pumping station systems at all times.
- E. Commissioning of all systems listed to include but not be limited to:
  - 1. All wire, cable, equipment, and systems installed or connected under control systems upgrade contract shall be tested to assure proper installation, setting, connection, and functioning in accordance with the drawings, specifications, and the manufacturer's recommendations. The intent herein is that field testing be extensive and complete as specified, to provide assurance of correct installation and operation of equipment.
  - 2. All tests and inspections recommended by the equipment manufacturer shall be included, whether required by these specifications or not, unless specifically waived in writing by the ENGINEER.

#### 3.02 COMMISSIONING AND SYSTEM INTEGRATION

- A. Commissioning shall be performed with all inter-related systems operating. In general, integrated system commissioning shall be operated through all modes of

operation (normal, emergency, interruption to the incoming services, manual operations). Verification of each mode in the sequences of operation is required.

- B. If a problem is detected while conducting commissioning, the problem will be identified and reported to the CONTRACTOR for diagnosis and correction. The failed portion shall be repeated after the repairs are completed.
- C. A combination punch list/checklist shall be maintained by the Integrator in spreadsheet format to monitor and track equipment commissioning and installation. The spreadsheet shall be an integral part of the weekly report documentation and must be included with final report.

### 3.03 CERTIFICATION

- A. Notification of Completion of Work
  - 1. Prior to acceptance of Work, the OWNER shall request from the CONTRACTOR a written notification certifying that:
    - a. Work has been completed in accordance with Contract Documents.
    - b. Work has been inspected for compliance with Contract Documents.
    - c. Work is ready for final inspection and site acceptance testing.
- B. Final Walk-Thru
  - 1. After receipt of the notification of completion of work, the ENGINEER or Project Manager will conduct a final walk-thru with the participation of the OWNER, CONTRACTOR, ENGINEER and other appropriate project team members to verify the status of the completion
- C. Final Punch List
  - 1. Should the ENGINEER consider that the Work is incomplete or defective:
    - a. The OWNER will notify the CONTRACTOR in writing, by form of a final punch list, listing the incomplete or defective Work.
    - b. The CONTRACTOR will take immediate steps to remedy the stated deficiencies and send a second or subsequent written certification to the ENGINEER stating that the Work is complete.
    - c. The ENGINEER or Project Manager will re-inspect the Work.
  - 2. Upon satisfaction that all the work is complete and all items in the Final Punch List addressed to the satisfaction of the ENGINEER, the OWNER and CONTRACTOR will sign-off on the final punch list indicating concurrence that the work is complete.
- D. Manuals and Records
  - 1. After final walk-thru and sign-off on the final punch list have been achieved the CONTRACTOR releases to the OWNER the following manuals and records kept, updated and/or developed during the project:
  - 2. Final documentation as specified in Section 16900.
  - 3. Training session forms.
  - 4. Copies of all punch lists.

3.04 TRAINING

- A. After the completion of commissioning and installation, designated OWNER personnel shall be trained in the operation and maintenance of all equipment and systems related to the project.
- B. Training shall consist of a formal one (1) day session wherein all procedures necessary to operate and maintain equipment and systems on a continuing basis are explained in full detail. Hands-on operations and maintenance tasks shall be executed to ensure that all aspects of the training are fully understood.
- C. Training shall be conducted on-site by the CSI and shall be offered to accommodate up to twelve (12) persons.
- D. Training times shall be determined and coordinated by the OWNER.

END OF SECTION 16992

## SECTION 260913 – ELECTRICAL POWER MONITORING AND CONTROL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Multifunction energy meters.
2. Power meters.
3. Circuit meters and monitors.
4. Circuit meter and explorer.
5. PC operating system software.
6. Networked PC operating system software.
7. Power monitoring and control software.
8. Network configuration software.
9. Monitoring and control of power distribution equipment.
10. System operator interfaces.
11. Desktop workstations.
12. Portable workstations.
13. Raceways and boxes.
14. Wires and cables.
15. Surge protection devices.

- B. Related Requirements:

1. Section 230923.13 "Energy Meters" for electricity meters for HVAC equipment.
2. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

#### 1.3 DEFINITIONS

- A. Active Power: The average power consumed by a unit. Also known as "real power."
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. Apparent (Phasor) Power: " $S = VI$ " where "S" is the apparent power, "V" is the rms value of the voltage, and "I" is the rms value of the current.



- D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.
- F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.
- G. LAN: Local area network.
- H. L-G: Line to ground.
- I. L-L: Line to line.
- J. L-N: Line to neutral.
- K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- L. Modbus TCP/IP: An open protocol for exchange of process data.
- M. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- N. N-G: Neutral to ground.
- O. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.
- P. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- Q. TCP/IP: Transport control protocol/Internet.
- R. UPS: Uninterruptible power supply; used both in singular and plural context.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For power monitoring and control equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.
  - a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:
    - 1) Location of the meters and gateways, and routing of the connecting wiring.
    - 2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Network naming and numbering scheme.
5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
6. Specifications for workstations.
7. UPS sizing calculations for workstation.
8. Surge Suppressors: Data for each device used and where applied.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
  - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
  - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
  - c. As-built versions of submittal Product Data.
  - d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
  - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
  - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

- g. Engineering, installation, and maintenance manuals that explain how to do the following:
  - 1) Design and install new points, panels, and other hardware.
  - 2) Perform preventive maintenance and calibration.
  - 3) Debug hardware problems.
  - 4) Repair or replace hardware.
- h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
- j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
- l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- m. Owner training materials.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power monitoring and control units to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating and upgrade manuals.
  - 2. Software licenses.
  - 3. Software service agreement.
  - 4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Provide separately for each PC.
  - 5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on compact disk or portable storage device with a USB interface of the hard-copy submittal.
  - 6. Program Software Backup: On compact disk or portable storage device with a USB interface, complete with data files.
  - 7. Device address list.
  - 8. Printout of software application and graphic screens.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

#### 1.9 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
  1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

### PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:
  1. Electrical meters that monitor, control, and connect to the data transmission network.
  2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
  3. Include a PC based computer with Web access, with its operating system and application software, connected to data transmission network.
- B. The electrical power monitoring and control system shall be Internet based.
  1. System software shall be based on server thin-client architecture, designed around open standards of internet technology.
  2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
  3. Internet access shall be password protected.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. UL Compliance: Listed and labeled as complying with UL 61010-1.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
  - 1. Minimum Protection for Power Lines 120 V and More: [SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.] Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
  - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
- B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.
- C. Interface with DDC System for HVAC: Provide factory-installed hardware and software to enable the DDC system for HVAC to monitor, display, and record data for use in processing reports.
  - 1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
  - 2. Use ASHRAE 135 (BACnet) [LonTalk] [Modbus] [Industry-accepted, open-protocol communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely monitor meter information from a DDC system for HVAC workstation. Control features and monitoring points displayed locally at metering panel shall be available through the DDC system for HVAC.
- D. Backup Power Source:
  - 1. Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

## 2.3 MULTIFUNCTION ENERGY METERS

- 1. Current Technology; a subsidiary of Danahar Corporation.
- 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  4. Liebert Corporation.
  5. Siemens Energy & Automation, Inc.
  6. Square D; a brand of Schneider Electric.
  7. OR Engineer Approved Equal.
- B. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.
1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
  2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor installation in non-air-conditioned, non-temperature-controlled spaces that have environmental controls to maintain ambient conditions of **4 deg to 158 deg F (minus 20 to plus 70 deg C)**] dry bulb and 5 to 95 percent relative humidity, noncondensing.
  2. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.
- D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
- E. Accuracy:
1. Comply with ANSI C12.20, Class 0.5.
  2. Neutral Current Measurement: Not more than 0.65 percent.
  3. Power Factor: 1.0 percent.
  4. Frequency: 0.1 percent.
  5. THD: 1.0 percent.
  6. Waveform Sampling: 64 per cycle.
- F. Data Link:
1. RS-485 Modbus, RTU protocol, [2] [4]-wire connection to host devices with a compatible port.
  2. **<Insert protocol>**.
- G. Meter Physical Characteristics:
1. Display: Backlit LCD with antiglare and scratch-resistant lens.
  2. Display of Metered Values:
    - a. One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:

- 1) All meters.
  - 2) Measurements.
  - 3) THD.
  - 4) Energy.
  - 5) Demand.
  - 6) Minimum and maximum values.
  - 7) Power demand.
- H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 60 samples per cycle, simultaneously on all voltage and current channels of the meter.
- I. Meters:
1. Instantaneous, rms:
    - a. Current: Each phase, Neutral and three-phase average.
    - b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    - c. Active Power (kW): each phase and three-phase total.
    - d. Reactive Power (kVAR): each phase and three-phase total.
    - e. Apparent Power (kVA): each phase and three-phase total.
    - f. Power Factor: each phase and three-phase total.
  2. Energy:
    - a. Active Energy (kWh): Three-phase total.
  3. Demand, Derived from Instantaneous rms Meters:
    - a. Current: Present and maximum.
    - b. Active: Present and maximum.
    - c. Reactive: Present and maximum.
    - d. Apparent: Present and maximum.
  4. Power Quality Measurements:
    - a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.
- J. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics shall be 150 mA at 200 V.
1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:
    - a. User-defined pulse output associated with kWh.
    - b. User-defined pulse output associated with kVARh.
- K. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz] <Insert text>.
2. Circuit Connections:
  - a. Voltage: Measurement auto ranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
  - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
  - c. Frequency: 45 to 65 Hz.
  - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

#### 2.4 POWER METERS <Insert drawing designation>

1. Current Technology; a subsidiary of Danahar Corporation.
  2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  4. Liebert Corporation.
  5. Siemens Energy & Automation, Inc.
  6. Square D; a brand of Schneider Electric.
  7. OR Engineer Approved Equal.
- B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.
1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
  2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor installation in non-air-conditioned non temperature-controlled spaces that have environmental controls to maintain ambient conditions of minus 4 to 158 deg F (minus 25 to plus 70 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
  2. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.
- D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
- E. Accuracy:



1. Comply with ANSI C12.20, Class 0.5.
  2. Neutral Current Measurement: Not more than 0.65 percent.
  3. Power: 0.6 percent.
  4. Power Factor: 0.5 percent.
  5. Active Energy: 0.6 percent.
  6. Reactive Energy: 2.5 percent.
  7. Frequency: 0.05 percent.
  8. THD: 1.0 percent.
  9. Waveform Sampling: 32 per cycle.
- F. Data Link:
1. RS-485 Modbus RTU protocol, 2 or 4 - wire connection.
    - a. Provide for firmware and software updates through the communications port.
- G. Meter Physical Characteristics:
1. Display: Backlit LCD with antiglare and scratch-resistant lens.
  2. Display of Metered Values: One screen to show at least **[four]** **<Insert number>** lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:
    - a. All meters, including those listed under the following:
      - 1) Measurements.
      - 2) THD.
      - 3) Energy.
      - 4) Demand.
      - 5) Minimum and maximum values.
      - 6) Power demand.
- H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on all voltage and current channels of the meter.
- I. Meters:
1. Measurements: Instantaneous, in real time, rms to the 15th harmonic.
    - a. Voltage: L-L each phase, L-N each phase, and three-phase average.
    - b. Current: Each phase, three-phase average, and neutral.
    - c. Unbalanced current, L-L V ac and L-N V ac.
    - d. Active Power (+/- kW): Each phase and three-phase total.
    - e. Reactive Power (+/- kVAR): Each phase and three-phase total.
    - f. Apparent Power (+/- kVA): Each phase and three-phase total.
    - g. Displacement Power Factor: Each phase and three-phase total.
    - h. Distortion Power Factor: Each phase and three-phase total.
    - i. Frequency.

2. THD from measurements simultaneously from the same cycle, through 15th harmonic.
    - a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
    - b. Current THD: Each phase and three-phase average.
    - c. Total demand distortion.
  3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.
    - a. Active kWh.
    - b. Reactive kVARh.
    - c. Apparent kVAh.
  4. Demand: Present, last, predicted, peak.
    - a. Three-phase average current.
    - b. Three-phase total active power (kW).
    - c. Reactive power (kVAR).
    - d. Apparent power (kVA).
  5. Minimum and Maximum Values:
    - a. L-L and L-N voltages.
    - b. Current in each phase.
    - c. Power factor.
    - d. Active power total.
    - e. Reactive power total.
    - f. Apparent power total.
    - g. THD L-L and L-N voltages.
    - h. THD current in each phase.
    - i. Frequency.
- J. Power Demand, User Selectable:
1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
  2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
    - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    - b. Fixed block that calculates demand at end of the interval.
    - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
  3. Demand Calculation Initiated by a Synchronization Signal:

- a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
  - b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
  - c. Provide for synchronizing the demand with the internal of this instrument.
- K. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.
1. Minimum and maximum of real-time rms measurement.
  2. Energy.
  3. Demand values.
  4. Alarms: store the last 40 events.
- L. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm shall be user configured, by using the following options:
1. Date and time stamp.
  2. Enable-disable (default) or enable.
  3. Pickup magnitude.
  4. Pickup time delay.
  5. Dropout magnitude.
  6. Dropout time delay.
  7. Alarm type.
  8. Alarm label.
- M. Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:
1. Normal contact closure where the contacts change state for as long as the signal exists.
  2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
  3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.
- N. Meter Face:
1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
  2. Display of Metered Values: One screen to show at least [four] <Insert number> user-selected values on one screen at the same time.
  3. Provide for the reset of metered peak values.
- O. Capacities and Characteristics:
1. Power Supply: 120-V ac, 60 Hz.
  2. Circuit Connections:

- a. Voltage: Measurements auto ranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
- b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
- c. Frequency: 45 to 65 Hz.
- d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

## 2.5 CIRCUIT METERS AND MONITORS <Insert drawing designation>

1. Current Technology; a subsidiary of Danahar Corporation.
  2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  4. Liebert Corporation.
  5. Siemens Energy & Automation, Inc.
  6. Square D; a brand of Schneider Electric.
  7. OR Engineer Approved Equal.
- B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
1. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor installation in non-air-conditioned non temperature-controlled spaces that have environmental controls to maintain ambient conditions of 14 to 122 deg F minus 10 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
  2. Comply with IEC 60529 degree of protection code of IP52 for the front of the meter, and code of IP30 for the back.
- D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
- E. Accuracy:
1. Comply with ANSI C12.20, Class 0.5.
  2. For Voltage and Current: 0.5 percent of reading.
  3. For Active Power: 0.2 percent.
  4. For Active and Reactive Energy: ANSI 12.20, Class 0.2.

5. For Frequency: 0.01 Hz in the range of 45 to 65 Hz.
6. For Power Factor: 0.2 percent from 0.5 leading to 0.5 lagging.

F. Data Links:

1. RS-485 Modbus RTU protocol, 2 or 4 - wire connection.
2. RS-232/RS-485 Modbus RTU/ASCII protocol, 2 or 4 - wire connection.
3. Modbus TCP:
  - a. 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
  - b. Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.
4. Provide for firmware and software updates through the communications port.
5. Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port.
6. Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port, Ethernet to serial line gateway, and embedded web server.

G. Meter Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

H. Sampling Rate:

1. Continuously sample and record voltage and current at a rate not less than 120, simultaneously on all voltage and current channels of the meter.

I. Meters shall measure, record with time stamp, calculate, and on request display the following:

1. Measurements: Instantaneous, in real time, rms to the 31<sup>st</sup>, 63<sup>rd</sup> harmonic:
  - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
  - b. Current: Each phase, three-phase average, and neutral.
  - c. Active Power (kW): Each phase and three-phase total.
  - d. Reactive Power (kVAR): Each phase and three-phase total.
  - e. Apparent Power (kVA): Each phase and three-phase total.
  - f. Displacement Power Factor: Each phase and three-phase total.
  - g. Distortion Power Factor: Each phase and three-phase total.
  - h. Frequency.
2. THD from measurements simultaneously from the same cycle, through 31<sup>st</sup>, 63<sup>rd</sup> harmonic:

- a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
  - b. Current: Each phase, three-phase average, and neutral.
3. Energy: Accumulated, indicate in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.
- a. Active kWh.
  - b. Reactive kVARh.
  - c. Apparent kVAh.
4. Demand: Three-phase totals, present, predicted, peak.
- a. Average current.
  - b. Active power (kW).
  - c. Reactive power (kVAR).
  - d. Apparent power (kVA).
5. Average, Minimum and Maximum Values:
- a. Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.
- J. Power Demand, User Selectable:
1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
  2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
    - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    - b. Fixed block that calculates demand at end of the interval.
    - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
  3. Demand Calculation Initiated by a Synchronization Signal:
    - a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
    - b. Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
    - c. Provide for synchronization to the clock in the instrument.
- K. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters.

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:
    - a. Every second for one minute for the one-minute curve.
    - b. Every minute for one hour for the one-hour curve.
    - c. Every hour for one day for the one-day curve.
    - d. Every day for one month for the one-month curve.
  2. Forecast the trended parameters for the following:
    - a. The next four hours.
    - b. The next four days.
- L. Waveform Capture:
1. Steady State Waveform Capture: Manually initiated.
    - a. Capture, record with time stamp, and store voltage and current waveforms for two cycles.
    - b. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.
    - c. Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 63rd.
    - d. Captured waveforms shall be recorded from actual circuit performance.
  2. Disturbance Waveform Capture:
    - a. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The waveform captures shall be user configurable from 185 cycles on 1 channel at 16 points per cycle, to 3 cycles on 6 channels at 128 points per cycle.
- M. Disturbance Detection and Alarm:
1. Detect and initiate alarm when detecting voltage or current sag and swell.
    - a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
    - b. Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
    - c. When detecting an alarm condition:
      - 1) Initiate disturbance waveform capture.

- 2) Record the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
- 3) Alarm on shall be visible on the display and be transmitted over the data link.
- 4) Display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

N. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2. The current and voltage information for all phases shall be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

O. Alarms: Alarm events shall be user definable. Provide a minimum of 40 user-defined alarm conditions.

1. User Configuration Options:

- a. Date and time stamp.
- b. Enable-disable (default) or enable.
- c. Pickup magnitude.
- d. Pickup time delay.
- e. Dropout magnitude.
- f. Dropout time delay.
- g. Alarm type.
- h. Alarm label.

2. The following classes of events shall be available to be programmed as alarm events:

- a. Over/under current.
- b. Over/undervoltage.
- c. Current imbalance.
- d. Phase loss, current.
- e. Phase loss, voltage.
- f. Voltage imbalance.
- g. Over kVA.
- h. Over kW or kVAR into/out of load.
- i. Over/under frequency.
- j. Under power factor, true or displacement.
- k. Over THD.
- l. Over demand, current or power.
- m. Reverse power.
- n. Phase reversal.
- o. Status input change.
- p. End of incremental energy interval.
- q. End of demand interval.



- r. Over/under analog inputs.
  - s. Current sag/swell.
  - t. Voltage sag/swell.
- 3. For each over/under metered alarm value, provide for the user to define a pickup, dropout, and delay.
  - 4. The circuit meter and monitor alarms response time shall be not less than one second.
  - 5. Provide for up to four alarms to be combined to give a single result using Boolean algebra operations.
- P. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.
- Q. I/O Module: Modular, with multiple I/O options to accomplish specified performance and one or more spare positions for future.
- 1. KY Pulse: Generate a standard KY pulses for a user-defined increment of metered active energy as follows:
    - a. User-defined pulse output associated with kWh.
    - b. Alarm pulse output, which turns on the pulsing at user-defined point.
  - 2. Digital Inputs: As follows:
    - a. One input connection rated 24- to 125-V ac or -V dc, +/- 10 percent, less than 5-mA burden, 1350-V rms isolation.
    - b. Six input connections rated 19- to 30-V dc, 5 mA maximum at 24-V dc. Provide an onboard 24-V dc power supply.
    - c. Two input connections rated 20- to 150-V dc or -V ac, 2 mA maximum.
  - 3. Analog inputs, no fewer than two, adjustable from 0- to 5-V dc or 4 to 20 mA.
  - 4. Outputs to operate field-installed relays, no fewer than two, providing 6- to 240-V ac or 6- to 30-V dc, 2 A rms. 5 A maximum for 10 seconds per hour.
  - 5. Analog outputs, no fewer than two, 4- to 20-mA dc into 600 ohms maximum.
- R. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.
- 1. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.
    - a. Each log entry shall hold data of up to 96 parameters each.
    - b. Each log shall be user configurable to log data at a different user-defined schedule interval.
    - c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
    - d. Configure log entries to be recorded as Fill & Hold or Circular (First in, First out, or FIFO), as defined by the user.

2. Minimum/Maximum Logs:
  - a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
  - b. Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the real-time metered values.
3. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
4. Waveform Logs: Capture and store waveforms, from 185 cycles on one channel at 16 samples per cycle, up to 3 cycles on six channels at 128 samples per cycle as defined by the user. Waveform log entries shall be externally triggered or forced in response to a user-defined event. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

S. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:
  - a. Voltage: Measurement auto ranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
  - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
  - c. Frequency: 45 to 65 Hz.
  - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.6 CIRCUIT METER AND EXPLORER

1. Current Technology; a subsidiary of Danahar Corporation.
  2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  4. Liebert Corporation.
  5. Siemens Energy & Automation, Inc.
  6. Square D; a brand of Schneider Electric.
  7. OR Engineer Approved Equal.
- B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring, control, and power quality explorer; complying with UL 61010-1.

1. Provide for metering 4-wire Y, 3-wire Y, and 3-wire delta power systems.
  2. Equip the instrument with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor installation in non-air-conditioned non temperature-controlled spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
  2. Comply with IEC 60529 degree of protection code of IP52.
  3. The circuit meter and monitor shall meet UL 61010-1 overvoltage withstand rating of CAT IV.
- D. Accuracy to the following plus/minus values:
1. Voltage and Current Meter: 0.04 percent of reading plus 0.025 percent of full scale.
  2. Power and Energy Meter: 0.075 percent of reading plus 0.025 percent of full scale.
  3. Energy Meter: Comply with ANSI C12.20, Class 0.20.
  4. Frequency Meter: 0.01 Hz in the range of 45 to 67 Hz and accurate to 0.1 Hz in the range of 350 to 450 Hz.
  5. Power Factor: 0.002 from 0.5 leading to 0.5 lagging.
- E. Data Links:
1. RS-232 port.
  2. RS-485 Modbus RTU protocol, 2 or 4 - wire connection.
  3. Ethernet Modbus/TCP/IP protocol:
    - a. 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
    - b. Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.
    - c. HTML server, with standard home page and five customizable pages.
  4. Firmware and software updates shall be accessible through the communications port.
- F. Physical Characteristics:
1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
  2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
  3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

- G. Sampling Rate:
1. Sample current and voltage to provide rms accuracy to 255th harmonic of the fundamental frequency of 60 Hz.
  2. Continuously sample and record voltage and current at a rate not less than 512 samples per cycle, simultaneously on all voltage and current channels of the meter.
- H. Measure, record with time stamp, and calculate; and, on request, display the following:
1. Measurements: Instantaneous, in real time, rms to the 63rd harmonic:
    - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, L-N three-phase average, and percent unbalanced.
    - b. Current: Each phase, neutral, ground, three-phase average, apparent rms, and percent unbalanced.
    - c. Active Power (kW): Each phase and three-phase total.
    - d. Reactive Power (kVAR): Each phase and three-phase total.
    - e. Apparent Power (kVA): Each phase and three-phase total.
    - f. Displacement Power Factor: Each phase and three-phase total.
    - g. Distortion Power Factor: Each phase and three-phase total.
    - h. Frequency.
    - i. K-factor for each phase.
  2. THD from measurements simultaneously from the same cycle, through 255th harmonic:
    - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    - b. Current: Each phase, three-phase average, and neutral.
    - c. Power: Active, reactive, and apparent power including power of up to 41st.
  3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.
    - a. Active kWh.
    - b. Reactive kVARh.
    - c. Apparent kVAh.
  4. Demand:
    - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
      - 1) Present.
      - 2) Running average.
      - 3) Last completed interval.
      - 4) Peak.
    - b. Current: Each phase, three-phase average, and neutral.

- 1) Present.
  - 2) Last completed interval.
  - 3) Minimum.
  - 4) Peak.
- c. Active Power (kW): Three-phase totals.
- 1) Last completed interval.
  - 2) Predicted.
  - 3) Peak.
  - 4) Coincident with peak kVA demand.
  - 5) Coincident with peak kVAR demand.
- d. Reactive Power (kVAR): Three-phase totals.
- 1) Last completed interval.
  - 2) Predicted.
  - 3) Peak.
  - 4) Coincident with peak kW demand.
  - 5) Coincident with peak kVA demand.
- e. Apparent Power (kVA): Three-phase totals.
- 1) Last completed interval.
  - 2) Predicted.
  - 3) Peak.
  - 4) Coincident with peak kW demand.
  - 5) Coincident with peak kVA demand.
- f. Distortion Power Factor: Three-phase totals.
- 1) Last completed interval.
  - 2) Predicted.
  - 3) Peak.
  - 4) Coincident with peak kVA demand.
  - 5) Coincident with peak kVAR demand.
- I. Average, Minimum and Maximum Values:
1. Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.
  2. Record, date and time stamp, and save maximum, minimum and average over a user-defined interval for the following metered values:
    - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    - b. Voltage Unbalance: L-L each phase and L-N each phase.
    - c. Current:
      - 1) rms each phase, three-phase average, and calculated neutral current.

- 2) Apparent, rms average.
- 3) Active Power (kW): Each phase and three-phase total.
  
- d. Demand Current: rms each phase and three-phase average.
- e. Reactive Power (kVAR): Each phase and three-phase total.
- f. Apparent Power (kVA): Each phase and three-phase total.
- g. Demand Active Power: Each phase and three-phase total.
- h. Demand Reactive Power: Each phase and three-phase total.
- i. Demand Apparent Power: Each phase and three-phase total.
- j. Accumulated Energy: MWh, MVAh, and MVARh.
- k. Reactive energy (MVARh) by quadrant.
- l. Power Factor: Three-phase displacement and distortion power factors.
- m. K-factor for each phase.
- n. THD L-L and L-N voltages.
- o. THD current in each phase and neutral.
- p. Frequency.

J. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
  - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes. The default setting shall be the 15-minute continuous sliding block.
  - b. Fixed block that calculates demand at end of the interval.
  - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
3. Demand Calculation Initiated by a synchronization signal. Synchronize demand with clock in the circuit meter and monitor.
  - a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
  - b. Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
  - c. Provide for synchronization to the clock in the instrument.
4. Record, date and time stamp, and save the following demand values of all rms metered values since the last reset, including the following:
  - a. Average demand current, per phase.
  - b. Peak demand current, per phase.
  - c. Average demand for active power, reactive power, and apparent power.
  - d. Predicted demand for active power, reactive power, and apparent power.
  - e. Peak demand for active power, reactive power, and apparent power.

- K. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters:
1. Record minimum, maximum, and average values of eight user-selected parameters as follows:
    - a. Every second for one minute for the one-minute curve.
    - b. Every minute for one hour for the one-hour curve.
    - c. Every hour for one day for the one-day curve.
    - d. Every day for one month for the one-month curve.
  2. Forecast the trended parameters for the following:
    - a. The next four hours.
    - b. The next four days.
- L. Power Analysis Values:
1. THD Voltage: L-L each phase, L-N each phase, and L-N three-phase average.
  2. THD Current: Each phase, three-phase average, and neutral current.
  3. Total demand distortion.
  4. K-factor for each phase.
  5. Crest factor, each phase.
  6. Displacement power factor.
  7. Fundamental voltage, magnitude and angle, each phase.
  8. Fundamental currents, magnitude and angle, each phase.
  9. Fundamental active power, each phase and three-phase total.
  10. Fundamental reactive power, each phase and three-phase total.
  11. Harmonic power, each phase and three-phase total.
  12. Phase rotation.
  13. Voltage and current unbalances.
  14. Harmonic magnitudes and angles, each phase.
  15. Distortion power.
  16. Distortion power factor.
- M. Waveform Capture:
1. Steady State Waveform Capture: Manually initiated over the communications network.
    - a. Capture, record with time stamp, and store voltage and current waveforms at a user-defined resolution of 16 to 512 samples/cycle for up to 30 seconds.
    - b. Capture, record with time stamp, and store 512 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.
    - c. Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 255th for the following:
      - 1) Voltage: L-N and L-G each phase.
      - 2) Current: Of each phase and neutral current.

- d. Captured waveforms shall be recorded from actual circuit performance.
2. Disturbance Waveform Capture:
    - a. Capture, record with time stamp, and store digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The captured waveform shall be at a user-defined resolution of 16 to 512 samples/cycle per second. The number of pre-alarm cycles shall be adjustable.
  3. Waveform samples shall be available for transmission over the communications network, for display, archival, and analysis at computer workstations.
- N. Transient Detection.
1. Detect and capture transient voltage surge events up to 10 kV L-L with a duration as short as 200 ns.
- O. Flicker Detection.
1. Detect and capture flicker events, defined by IEEE 1453, at three levels: instantaneous, short term, and long term.
  2. Display the flicker event as plots of magnitude versus time on semi-log graph background.
- P. Sag and Swell Detection and Alarm:
1. Detect and initiate alarm when detecting voltage or current sag and swell.
    - a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
    - b. Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
    - c. When detecting an alarm condition:
      - 1) Initiate disturbance waveform capture.
      - 2) Initiate 100-ms event recording.
      - 3) Recording the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
      - 4) Causing an alarm on the display and transmit the alarm over the data link.
      - 5) The user shall have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.



- Q. 100-ms Event Recording: Capture, record with time stamp, and store.
1. Initiate recording by an alarm or external contact closure.
  2. User-configured recording, to record for the duration of the alarm up to 300 seconds and can be delayed for 1 to 10 seconds.
  3. Records current per-phase and neutral, voltage L-L each phase and L-N each phase, active power per-phase and three-phase total, reactive power each phase and three-phase total, apparent power each phase and three-phase total, and true power factor three-phase total.
  4. Operate an output relay in the I/O module of the instrument.
- R. Harmonics Information:
1. Calculate the harmonic magnitudes and angles for each phase voltage and current in each phase and neutral, through the 255th harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
  2. The current and voltage information for all phases shall be obtained simultaneously from the same cycle.
  3. Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.
- S. Alarms:
1. Alarm events may be either user defined or preconfigured by manufacturer from the applicable standards. Provide for multiple levels for each alarm that is based on metered data.
  2. The instrument shall calculate the listed key electrical parameters at not less than 100-ms intervals to initiate and record an alarm event. Provide for user-selected range of 1 to 10 seconds of pre-event and up to five minutes of post-event data recording.
  3. The following classes of events shall be available to be programmed as alarm events:
    - a. Over/under current.
    - b. Over/undervoltage.
    - c. Current imbalance.
    - d. Phase loss, current.
    - e. Phase loss, voltage.
    - f. Voltage imbalance.
    - g. Wave shape alarm.
    - h. Over kVA.
    - i. Over kW or kVAR into/out of load.
    - j. Over/under frequency.
    - k. Under power factor, true or displacement.
    - l. Over THD.
    - m. Over K-factor.
    - n. Over demand, current or power.
    - o. Reverse power.
    - p. Phase reversal.
    - q. Status input change.

- r. End of incremental energy interval.
  - s. End of demand interval.
  - t. Over/under analog inputs.
  - u. Current sag/swell.
  - v. Voltage sag/swell.
  - w. Transient events.
4. For each over/under metered alarm value, the user shall define a pickup, dropout, and delay.
5. Waveform Alarms:
- a. The instrument shall detect anomalous waveform events that are less than half-cycle in length.
  - b. Provide for the user to set a threshold value and an upper limit to determine whether the waveform triggers an alarm. The threshold value and upper limit shall be a value between 1 and 100. The threshold value is the limit at which a waveform triggers the alarm. The upper limit defines the highest waveform value that triggers a waveform alarm. The settable values are as follows:
    - 1) Phase voltages.
    - 2) N-G voltages.
    - 3) Phase currents.
    - 4) Neutral currents.
  - c. In response to a waveform alarm, the instrument shall:
    - 1) Log the event and record phase currents and voltages as defined in the 100-ms event recording.
    - 2) Determine the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, or high) of the accuracy of the source location.
6. Provide four alarm severity levels to allow the user to respond to the most important events first.
7. Indicate an alarm condition on the front panel of the instrument, as well as reported over the data link to designated workstations.
8. The circuit meter and monitor alarms response time shall be not less than the following:
- a. Standard, one second.
  - b. High speed, 100 ms.
  - c. Disturbance, half-cycle.
9. Up to four alarms may be combined to give a single result using Boolean algebra operations.
10. Provide e-mail notification of alarm conditions.
11. Automatic Alarm Set-Point Adjustment:
- a. The instrument software shall provide for recognizing and learning the characteristics of the normal operation of the electrical power system it is

- connected to, and to select and adjust alarm set points based on that recognition.
- b. The metered data to be recognized and learned, and the period of time for learning for alarms, disturbances, and waveform alarms, shall be set by the user by selection one of the following two modes:
    - 1) Fixed Learning: Initially configured user set points are used during the entire learning period.
    - 2) Dynamic Learning: Initially configured user set points are temporarily replaced by learned set points at the interval specified by the user in the learning setup. The set points continue to be updated at the specified interval until the learning period expires.
  - c. The learning period shall be user configurable. If the learned set points do not change over a predefined period, the learning process can be stopped and the set points either installed or held for review.
- T. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.
- U. I/O Module: Modular, with multiple I/O options, programmable to accomplish specified performance and one or more spare positions for future. At minimum, the instrument shall provide the following:
1. KYZ Pulse: Solid-state output relay, programmed to generate a standard KYZ pulses for a user-defined increment of metered active energy as follows:
    - a. User-defined pulse output associated with kWh.
    - b. Alarm pulse output, which turns on the pulsing at user-defined point.
  2. Digital inputs, each having the following operating modes:
    - a. Normal: Simple on/off digital inputs.
    - b. Demand Interval Synch Pulse Accept a demand synch pulse from a utility demand meter.
    - c. Conditional Energy Control input to control conditional energy accumulation.
  3. Output Relays and Control: Output relays shall have normally open and normally closed contacts and shall operate in response to a user sent command over the data link, or automatically responding to an alarm event. The relays shall be user configured in one of the following listed modes:
    - a. Normal contact closure where the contacts change state for as long as the signal exists.
    - b. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
    - c. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

- d. End of Power Demand Interval: When the relay operates as a synch pulse for other devices.
- e. Energy Pulse Output: Relay will pulse quantities used for Absolute kWh, Absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
- f. Programmed Output: Relay will operate in response to multiple alarms that are arranged to give a single result using Boolean algebra operations.

V. Onboard Data Logs:

1. Log data, alarms and events, and waveforms in onboard solid-state nonvolatile memory.
2. Onboard data logs shall be available for transmission over the communications network for display, archival, and analysis at computer workstations on demand.
3. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.
  - a. Each log entry shall hold data of up to 96 parameters each.
  - b. Each log shall be user configurable to log data at a different user-defined schedule interval.
  - c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
  - d. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.
4. Minimum/Maximum Logs:
  - a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
  - b. Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the active-time metered values.
5. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. The log capacity shall be not less than 1000 events. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
6. Waveform Logs: Capture and store waveforms as follows:
  - a. One cycle, 512 samples, to the 255th harmonic. Manually triggered.
  - b. Adjustable from 8 seconds at 18 samples per cycle, to 264 seconds at 16 samples per cycle. Triggered manually or by a user set alarm.
  - c. Voltage sampling at 5 MHz (83,333 samples per cycle) more than 2 ms to capture transient peaks of less than 1 microsecond.

W. Programming: Programming of instrument functions shall be similar to BASIC syntax. Provide for initial programming and changes to programs through the communications links.

1. Programming language shall include the following capabilities:

- a. Scheduled tasks.
  - b. Event tasks.
  - c. Math functions including add, subtract, multiple, divide, sine, cosine, and square root.
  - d. Logical functions including: AND, OR, XOR, NOT, shift, and so forth.
  - e. Loop commands.
  - f. Compare statements.
  - g. Counters and timers.
2. Manufacturer shall provide custom programs to meet Project requirements that are described in the "Capacities and Characteristics" Paragraph.
  3. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
  4. Data reduction using smart data logging.
  5. Automatic monthly logging/reset of kWh and peak demand.
  6. Statistical profile analysis of metered quantities.
  7. ITIC/SEMI power quality analysis.
  8. Calculations for IEEE 519 verification.
  9. Metering of combined utilities: gas, water, steam, and electric.
  10. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions, for example, time of day and input status.

X. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:
  - a. Voltage: Measurements auto ranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater.
  - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 15 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
  - c. Frequency: 45 to 67 Hz, and 350 to 450 Hz.
  - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.
3. Onboard, Field-Upgradeable, Solid-State Nonvolatile Memory: 8 MB.
4. Number of Onboard Data Logs: 14.
5. Number of Minimum/Maximum Log Files: two.
6. Alarm Log Capacity: Not less than 1000 events.
7. Custom Programs: Provide the following programs with the instrument:
  - a. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
  - b. Data reduction using smart data logging.
  - c. Automatic monthly logging/reset of kWh and peak demand.
  - d. Statistical profile analysis of metered quantities.

- e. Calculations for IEEE 519 verification.
- f. Metering of combined utilities: gas, water, steam, and electric.
- g. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions such as time of day and input status.

## 2.7 PC OPERATING SYSTEM SOFTWARE

- A. Description: System software shall monitor, analyze, display, control, and save all the parameters and features available at the connected meter.
- B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.
- C. Minimum Requirements:
  - 1. Real-time multitasking and multiuser 64bit operating system that allows execution of multiple real-time programs and custom program development.
  - 2. Operating system shall be capable of operating Microsoft Windows applications.
  - 3. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

## 2.8 NETWORKED PC OPERATING SYSTEM SOFTWARE

- A. Description: System software shall monitor, analyze, display, control, and save parameters and features available at each of the connected meters.
- B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be web enabled.
- C. System Software Minimum Requirements:
  - 1. Real-time multitasking and multiuser 64bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
  - 2. Operating system shall be capable of operating Microsoft Windows applications.
  - 3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
  - 4. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.
- D. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity.
6. Security Access:
  - a. Operator access to electrical monitoring and control system shall be under password control.
  - b. An alphanumeric password shall be user assignable to each operator.
  - c. Software shall have at least five access levels.
    - 1) View - View information. No change privileges allowed.
    - 2) User - Same as View but can initiate control functions.
    - 3) Controller - Same as User but can initiate communications.
    - 4) Operator - Same as Controller but can modify configurations.
    - 5) Supervisor - Same as Operator but can administer security privileges.
  - d. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
  - e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

E. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such shall be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

## 2.9 POWER MONITORING AND CONTROL SOFTWARE

A. Data Storage and Data Sharing:

1. Query and download logs of interval data stored on metering devices.
2. Query and download logs of alarm and event data stored on metering devices.
3. Query and download logs of waveform capture data stored on metering devices.
4. Query and download logs of interval data generated by the software and calculated by the meters.

5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
6. Automatically re-arm the waveform recorders, on upload of information.
7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
8. Provide a facility to view historical data from archived databases.
9. Support user changes to the database.
  - a. Support on-line changes while the data storage/retrieval application is running.
  - b. Suffer no interruption to its operation while changes are being made.
  - c. Require no restart once the configuration has been performed.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2. Plan for each building floor, showing the following:
  - a. Locations and identification of all monitored and controlled electrical equipment.
3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation with device identification.
4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, gateways and other Network devices.

## 2.10 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:

1. Add and remove devices in the power monitoring and control network.
2. Application for naming devices based on a user-defined naming scheme.
3. Add and remove I/O servers in the power monitoring and control network.
4. Edit communication properties for devices including timeouts and delays.
5. Display mandatory fields when adding a new device.
6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
8. Pool modem resources so that the software uses any available modem.
9. Monitor the following diagnostics:
  - a. Communication request/response and error rates, and timeouts.
  - b. Log acquisition services.



B. Database Maintenance Features:

1. Backup, archive, and trim data, event, and waveform logs.
  - a. Record start and end date for operation.
  - b. Allow copying data to another database.
  - c. Be capable of selecting any or all of the logs specified for the meters that are Work of this Section.
    - 1) Data logs.
    - 2) Event logs.
    - 3) Waveform logs.

C. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

1. Features:
  - a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
  - b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
  - c. Distribution of reports via email.
2. Report on power and demand profiles.
3. Power quality report with CBEMA evaluation.
4. EN 50160 compliance report.
5. 100-ms PQ report.
6. Energy over Period Report:
  - a. User-defined rollup interval by day, week, month, or year.
  - b. Compare daily energy to the following:
    - 1) Previous day.
    - 2) Same day, previous week.
    - 3) Same day, previous month.
    - 4) User-defined specific day.
  - c. Compare weekly energy to the following:
    - 1) Previous week.
    - 2) Same week from previous month.
    - 3) Same week from previous year.
    - 4) User-defined specific week.
  - d. Compare monthly energy to the following:
    - 1) Previous month.
    - 2) Same month from previous year.
    - 3) User-defined specific month.

- e. Compare annual energy to the following:
  - 1) Previous year.
  - 2) User-defined specific year.
7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
9. Trend Report:
  - a. Show values for multiple measurements and measurements from multiple devices in any of the following graphical formats:
    - 1) Line chart.
    - 2) Pie graph.
    - 3) Bar chart.
    - 4) Column chart.
    - 5) Smooth line chart.
    - 6) Stacked column chart.
    - 7) Stacked bar chart.
10. Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
11. System Configuration Report:
  - a. Device name.
  - b. Device type.
  - c. Device address.
  - d. Connection status.
  - e. Device protocol.
  - f. Device description.
12. Each default report shall include the following:
  - a. Summary aggregation of data from the selected devices.
  - b. Individual device information.
  - c. Raw data.
13. The reporting tool shall provide a graphical interface to create and manage multiple Time of Use schedules:
  - a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
  - b. Off-peak and on-peak times.

## 2.11 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

- A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

- B. Instrument Transformers: Comply with IEEE C57.13.
  - 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
  - 2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.
  
- C. Ethernet Connectivity:
  - 1. A multipoint, RS-485 Modbus serial communications network shall be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
  - 2. Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.
  - 3. Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.
  
- D. Ethernet Gateways:
  - 1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
  - 2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Owner.
  - 3. Common Gateway Features:
    - a. User configurable, with secure password-protected login process.
    - b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
    - c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's RS-485 port(s) through a standard web browser.
    - d. Allow firmware upgrades through the communications port.
  - 4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
  - 5. Implement a common user interface ("look and feel") across all styles of power equipment.
  
- E. Distribution Equipment Monitoring:
  - 1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
  - 2. Display Data:

- a. Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).
- b. Load current summary page to display circuit name, and phase a, b, and c rms current values.
- c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
- d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
- e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
- f. For unit substations equipped with dry-type transformer(s) and micro based temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
- g. For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

## 2.12 SYSTEM OPERATOR INTERFACES

### A. Operator means of system access shall be through the following:

1. Desktop workstation with hardwired connection through LAN port.
2. Portable terminal with hardwired connection through LAN port at each meter.
3. Remote connection using outside of system PC, tablet, or phone using an internet portal.

## 2.13 DESKTOP WORKSTATIONS

### A. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Capable of running Microsoft Windows.
3. ENERGY STAR compliant.

### B. Personal Computer:

1. Minimum Processor Speed: 3+Ghz or higher, Intel Core i5 (sixth generation or newer) or equivalent.
2. RAM:
  - a. Capacity: 32GB (2 x 16GB).
  - b. Speed and Type: 3200Mhz or higher DDR4.
3. Primary Hard Drive:
  - a. Media: Solid State.

- b. Capacity: 2TB
  - 4. Second Hard Drive:
    - a. Media: Solid State
    - b. Capacity: 1TB
  - 5. Expansion Slots: Minimum of 4, 64bit.
  - 6. Video Card:
    - a. Capable of supporting three monitors.
    - b. RAM: 4GB minimum
    - c. Controller Speed: 1000Mhz or faster.
  - 7. Sound Card:
    - a. At least 128 voice wavetable synthesis.
    - b. Capable of delivering three-dimensional sound effects.
    - c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
  - 8. Network Interface Card: Include card with connection, as applicable.
    - a. 10-100-1000 base TX Ethernet with RJ45 connector port.
    - b. 100 base FX Ethernet with SC or ST port.
  - 9. Wireless Ethernet, 802.11 a/b/g/n.
  - 10. Optical Modem: Full duplex link for connection to optical fiber cable provided.
  - 11. I/O Ports:
    - a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    - b. One serial port.
    - c. One parallel port.
    - d. Two PS/2 ports.
    - e. One RJ-45.
    - f. One stereo line-in and line-out on back panel.
    - g. One microphone and headphone connector on front panel.
    - h. One IEEE 1394 on front and back panel with PCI-e card.
    - i. One ESATA port on back panel.
  - 12. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.
- C. Keyboard:
- 1. 101-key enhanced keyboard.
  - 2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
  - 3. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

D. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

E. Flat Panel Display Monitor:

1. Number of Displays: three.
  - a. Display Support: Desk mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization. OR Wall mounted, adjustable bracket capable of supporting some portion of the specified monitors.
2. Color display with 24 **inches (mm)** diagonal viewable area minimum.
3. Resolution: 1920 by 1080 pixels at 60 Hz with pixel size of 0.277 mm or smaller.
4. Digital input signal.
5. Dynamic Contrast Ratio: 50000 to 1.
6. Brightness: 250 cd/sq. m.
7. ENERGY STAR compliant.
8. Antiglare display.

F. Speakers:

1. Two, with individual controls for volume, bass, and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

G. I/O Cabling: Include applicable cabling to connect I/O devices.

H. Software:

1. Factory-installed operating system.

2.14 RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.15 WIRES AND CABLES

- A. Electrical Power Wiring: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Copper conductors are Type THHN/THWN-2.
- B. Control Wiring: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
1. Optical-Fiber Cable: Multimode, 50/125-micrometer OM3, six-fiber, nonconductive, tight-buffer, optical-fiber cable, with aqua jacket.
  2. Balanced Twisted Pair Cable: 100-ohm, four-pair Category 6.
  3. Workstation Outlets: Four-port-connector assemblies mounted in single or multi-gang faceplate. Coordinate color and labels with Section 262726 "Wiring Devices."
  4. RS-485 Cable: Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
  5. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
    - a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
    - b. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
    - c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.
- C. RS-232 Cable:
1. PVC-Jacketed, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - a. Type CM.
    - b. Flame Resistance: UL 1581, vertical tray.
  2. Plenum-Type, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - a. Type CMP.
    - b. Flame Resistance: NFPA 262, flame test.

## 2.16 SURGE PROTECTION DEVICES

- A. SPDs: Comply with UL 1449, Type 1.
1. Include LED indicator lights for power and protection status.
  2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.
- C. Comply with UL 1283.
- D. Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277 V [208Y/120 V], three-phase, four-wire circuits shall not exceed the following:
  1. L-N: 1200 V for 480Y/277 V] [700 V for 208Y/120 V.
  2. L-G: 1200 V for 480Y/277 V] [700 V for 208Y/120 V.
  3. N-G: 1200 V for 480Y/277 V] [700 V for 208Y/120 V.
  4. L-L: 2000 V for 480Y/277 V] [1200 V for 208Y/120 V.
- E. Protection modes and UL 1449 SPD for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
  1. L-N: 700 V.
  2. L-G: 700 V.
  3. N-G: 700 V.
  4. L-L: 1200 V.
- F. SCCR: Equal or exceed 100 kA.
- G. Nominal Rating: 20 kA.
- H. Indoor Enclosures: NEMA 250, Type 1.
- I. Outdoor Enclosures: NEMA 250, Type 4X.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF POWER MONITORING AND CONTROL SYSTEMS

- A. Comply with NECA 1.



- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- D. Wiring and Cabling Installation:
  - 1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
  - 2. Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.
- E. Raceways Installation:
  - 1. Comply with Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
  - 2. Comply with Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.
- F. Identification Installation:
  - 1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
  - 2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, RS-485 cable, low-voltage control cable, and RS-232 cable.
  - 3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

### 3.3 INSTALLATION OF WORKSTATIONS

- A. Desktop Workstations Installation:
  - 1. Install workstation(s) at location(s) directed by Owner.
  - 2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
  - 3. Install software on workstation(s) and verify that software functions properly.
  - 4. Develop Project-specific graphics, trends, reports, logs, and historical database.
  - 5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.
- B. Portable Workstations Installation:
  - 1. Turn over portable workstations to Owner at Substantial Completion.
  - 2. Install software on workstation(s) and verify that software functions properly.

C. Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Architect's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the system operation and maintenance manual.

3.4 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.5 GROUNDING

- A. For data communication wiring, comply with NECA/BICSI 568.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA-568-C.1.
  3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
  - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  - b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.
5. Optical-Fiber Cable Tests:
  - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  - b. Link End-to-End Attenuation Tests:
    - 1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.
    - 2) Attenuation test results for links shall be less than **[2.0 dB] [that calculated according to equation in TIA-568-C.0]**.
  - c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.
6. Power Monitoring and Control System Tests.
  - a. Test Analog Signals:
    - 1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
    - 2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
    - 3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
  - b. Test Digital Signals:
    - 1) Check digital signals using a jumper wire.
    - 2) Check digital signals using an ohmmeter to test for contact making or breaking.
  - c. I/O Control Loop Tests:

- 1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
- 2) Test every I/O point throughout its full operating range.
- 3) Test every control loop to verify that operation is stable and accurate.
- 4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
- 5) Test and adjust every control loop for proper operation according to sequence of operation.
- 6) Test software and hardware interlocks for proper operation.
- 7) Operate each analog point at the following:
  - a) Upper quarter of range.
  - b) Lower quarter of range.
  - c) At midpoint of range.
- 8) Exercise each binary point.
- 9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument shall match.
- 10) Prepare and submit a report documenting results for each I/O point in the system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

D. Wiring and cabling will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

### 3.7 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when the power monitoring and control system is ready for final review. Written request shall state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Review by Architect and Construction Manager will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Final review shall include a demonstration to parties participating in final review.

### 3.8 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

### 3.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

### 3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the power monitoring and control system.
- B. Extent of Training:
  - 1. Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
  - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
  - 3. Minimum Training Requirements:
    - a. Provide no fewer than four days of training total.
    - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
    - c. Total days of training shall be broken into not more than two separate training classes.
    - d. Each training class shall be no fewer than two consecutive days.

C. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

D. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have no fewer than five years of providing instructional training or no fewer than 10 past projects with similar electrical monitoring and control system scope and complexity.

E. Training Outline: Submit training outline for Owner review at least 15 business days before scheduling training. Outline shall include a detailed agenda for each training day that is broken down into each training session that day, training objectives for each training session, and synopses for each lesson planned.

F. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system shall be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

G. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

3.11 At Completion of Training:

- A. Staff familiar with the system installed can demonstrate operation of the system during final review.

- B. Demonstration shall include, but not be limited to, the following:
1. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
  2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
  3. Trends, summaries, logs, and reports set-up for Project.
  4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
  5. Software's ability to edit control programs off-line.
  6. Data entry to show Project-specific customizing capability including parameter changes.
  7. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
  8. Execution of digital and analog commands in graphic mode.
  9. Spreadsheet and curve plot software and its integration with database.
  10. Online user guide and help functions.
  11. For Each Meter:
    - a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    - b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    - c. Wiring Labels: Match control drawings.
    - d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    - e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.
  12. For Each Workstation:
    - a. I/O point lists agree with naming conventions.
    - b. Graphics are complete.
    - c. UPS unit, if applicable, operates.

END OF SECTION 260913

## SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

#### 1.3 This Section includes dry-type distribution transformers rated 600 V and less, with capacities up to 1000 kVA SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.



- D. Field quality-control test reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
- B. Manufacturer shall provide copies of following documents to owner for review and evaluation:
  - 1. Product data and spare parts list;

#### 1.6 QUALITY ASSURANCE

- A. Testing Qualifications: Engage manufacturer with the experience and capability to conduct the testing to NETA standards.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

#### 1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Electric Corporation.
  2. Challenger Electrical Equipment Corp.
  3. Controlled Power Company.
  4. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Products.
  5. Federal Pacific Transformer Company.
  6. General Electric Company.
  7. Hammond Co.
  8. Magnetek Power Electronics Group.
  9. Micron Industries Corp.
  10. Myers Power Products, Inc.
  11. Siemens Energy & Automation, Inc.
  12. Sola/Hevi-Duty.
  13. Square D Co./Schneider Electric.
  14. Alternate as approved by Engineer

### 2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
  2. Coil Material: Copper unless otherwise specified.

### 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Indoor Transformer Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Outdoor Transformer Enclosure: Totally enclosed, nonventilated, NEMA 250, Type 4X, stainless steel

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: ANSI 61 gray.
- G. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
  2. Tested according to NEMA TP 2.
- L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  2. Indicate value of K-factor on transformer nameplate.
- M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  2. Include special terminal for grounding the shield.
  3. Shield Effectiveness:
    - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
    - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
    - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- N. For wall mounted transformers, wall Brackets: Manufacturer's standard brackets.
- O. For tropical or sub tropic environments, provide fungus proofing, permanent fungicidal treatment for coil and core.

- P. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
- Q. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
  - 1. 9 kVA and Less: <40 dBA
  - 2. 30 to 50 kVA: <45 dBA
  - 3. 51 to 150 kVA: <50 dBA
  - 4. 151 to 300 kVA: <55 dBA
  - 5. 301 to 500 kVA: <60 dBA
  - 6. 501 to 750 kVA: <62 dBA
  - 7. 751 to 1000 kVA: <64 dBA

## 2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Brace wall-mounting transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions Section 260548.16 "Seismic Controls for Electrical Systems.", and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

### 3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
  - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### 3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.
- C. Adjust all access doors and operating handles for free mechanical operation as described in manufacturer's instructions.

### 3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- B. Repaint scratched or marred exterior surfaces to match original finish.

END OF SECTION 262200

## SECTION 262413 – SWITCHBOARDS

### GENERAL

### RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### SUMMARY

Section Includes:

- Service and distribution switchboards rated 600 V and less.
- Transient voltage suppression devices.
- Disconnecting and overcurrent protective devices.
- Instrumentation.
- Control power.
- Accessory components and features.
- Identification.

### PERFORMANCE REQUIREMENTS

Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### ACTION SUBMITTALS

Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

Shop Drawings: For each switchboard and related equipment.

Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

Detail enclosure types for types other than NEMA 250, Type 1.

Detail bus configuration, current, and voltage ratings.

Detail short-circuit current rating of switchboards and overcurrent protective devices.

Detail utility company's metering provisions with indication of approval by utility company.

Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

Include schematic and wiring diagrams for power, signal, and control wiring.

## INFORMATIONAL SUBMITTALS

Qualification Data: For qualified Installer.

Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

Field Quality-Control Reports:

Test procedures used.

Test results that comply with requirements.

Results of failed tests and corrective action taken to achieve test results that comply with requirements.

## CLOSEOUT SUBMITTALS

Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

Routine maintenance requirements for switchboards and all installed components.

Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

## MAINTENANCE MATERIAL SUBMITTALS

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.



Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

## QUALITY ASSURANCE

Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Comply with NEMA PB 2.

Comply with NFPA 70.

Comply with UL 891.

## DELIVERY, STORAGE, AND HANDLING

Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation. Contractor to provide all required temporary wiring for heaters.

Handle and prepare switchboards for installation according to NEMA PB 2.1.

## PROJECT CONDITIONS

Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

Environmental Limitations:

Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

Rate equipment for continuous operation under the following conditions unless otherwise indicated:

Ambient Temperature: Not exceeding 104 deg F (40 deg C).

Altitude: Not exceeding 6600 feet (2000 m).

Service Conditions: NEMA PB 2, usual service conditions, as follows:

Ambient temperatures within limits specified.

Altitude not exceeding 6600 feet (2000 m).

Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

Notify Engineer and Owner no fewer than 10 working days in advance of proposed interruption of electric service.

Indicate method of providing temporary electric service.

Do not proceed with interruption of electric service without Engineer's and Owner's written permission.

Comply with NFPA 70E.

## COORDINATION

Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

## WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

Warranty Period: Five years from date of Substantial Completion.

## PRODUCTS

### MANUFACTURED UNITS

Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

Eaton Electrical Inc.; Cutler-Hammer Business Unit.  
General Electric Company; GE Consumer & Industrial - Electrical Distribution.  
Square D; a brand of Schneider Electric  
or Approved Equal.

Front-Connected, Front-Accessible Switchboards:

Main Devices: Fixed, individually mounted.  
Branch Devices: Panel mounted.  
Sections front and rear aligned.

Front- and Side-Accessible Switchboards:

Main Devices: Fixed, individually mounted.  
Branch Devices: Panel mounted.  
Sections front and rear aligned.

Front- and Rear-Accessible Switchboards:

Main Devices: Draw-out mounted (When specifically shown on the One-Line Diagram).  
Branch Devices: Individually compartmented and draw-out mounted (When specifically shown on the One-Line Diagram).  
Sections front and rear aligned.

Nominal System Voltage: As Shown on the One-Line Diagram

Main-Bus Continuous: As shown on the One-Line Diagram

Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

Indoor Enclosures: Steel, NEMA 250, Type 1.

Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

Outdoor Enclosures: Type 3RX, Stainless Steel, Non-Walk-in.

Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.

Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking.

:

Barriers: Between adjacent switchboard sections.

Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point (exterior mounted switchboards only).

Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features. (When shown on the One-Line Diagram)

Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks (When shown on the One-Line Diagram)

Pull sections in first paragraph below may be required if incoming supply is beneath switchboard.

Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Set back from front to clear circuit-breaker removal mechanism.

Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.

Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.

Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

Buses and Connections: Three phase, four wire unless otherwise indicated.

Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with tin-plated aluminum or copper feeder circuit-breaker line connections.

Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C. (only if specifically noted on the drawings or installed below ground level.)

Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

## SURGE PROTECTION DEVICES

Provide Surge Protection Devices in accordance with SECTION 264313 – "SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS" as indicated on the one-line diagram or Switchboard Schedule.

## DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

Instantaneous trip.

Long- and short-time pickup levels.

Long- and short-time time adjustments.

Ground-fault pickup level, time delay, and  $I^2t$  response.

Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

Standard frame sizes, trip ratings, and number of poles.

Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system when specifically shown on the control drawings.

Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

Kirk Key Interlock when specifically shown on the drawings.

Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

Draw out circuit-breaker mounting.

Two-step, stored-energy closing.

Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

Instantaneous trip.

Long- and short-time time adjustments.

Ground-fault pickup level, time delay, and  $I^2t$  response.

Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

Remote trip indication and control.

Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system When specifically shown on the drawings.

Kirk Key Interlock when specifically shown on the drawings.

Control Voltage: 120-V ac.

## INSTRUMENTATION

Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

Phase Currents, Each Phase: Plus, or minus 1 percent.

Phase-to-Phase Voltages, Three Phase: Plus, or minus 1 percent.

Phase-to-Neutral Voltages, Three Phase: Plus, or minus 1 percent.

Megawatts: Plus, or minus 2 percent.

Megavars: Plus, or minus 2 percent.

Power Factor: Plus, or minus 2 percent.

Frequency: Plus, or minus 0.5 percent.

Accumulated Energy, Megawatt Hours: Plus, or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

Megawatt Demand: Plus, or minus 2 percent; demand interval programmable from five to 60 minutes.

Contact devices to operate remote impulse-totalizing demand meter.

Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

## CONTROL POWER

Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## ACCESSORY COMPONENTS AND FEATURES

Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each draw out circuit breaker.

Remote operation for remote operation of all breakers over 800 Amps

Remote racking device for all rack mounted circuit breakers.

## IDENTIFICATION

Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

## EXECUTION

### EXAMINATION

Receive, inspect, handle, and store switchboards according to [NEMA PB 2.1.

Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

Proceed with installation only after unsatisfactory conditions have been corrected.

## INSTALLATION

Install switchboards and accessories according to NEMA PB 2.1.



Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness

Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

Install anchor bolts to elevations required for proper attachment to switchboards.

Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

Install filler plates in unused spaces of panel-mounted sections.

Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

Set field-adjustable switches and circuit-breaker trip ranges.

Install spare-fuse cabinet.

Comply with NECA 1.

## IDENTIFICATION

Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

Device Nameplates: Label each disconnecting, and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## FIELD QUALITY CONTROL

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

Perform tests and inspections.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

Acceptance Testing Preparation:

Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

Test continuity of each circuit.

Tests and Inspections:

Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

Perform the following infrared scan tests and inspections and prepare reports:

Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.

Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.

Instruments and Equipment:

Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

Switchboard will be considered defective if it does not pass tests and inspections.

Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

#### ADJUSTING

Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

Set field-adjustable circuit-breaker trip ranges as specified in "Overcurrent Protective Device Coordination Study" performed by the contractor.

#### PROTECTION

Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

#### DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

## SECTION 262416 – PANELBOARDS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Electronic-grade panelboards.

#### 1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Protection Device

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 6. Include wiring diagrams for power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.

- B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field Quality-Control Reports:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing indicating the connected load for each breaker in accordance with the NEC. Schedule to be typed and dated.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Provide spare breakers as shown in the schedules on the drawings
  - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

#### 1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with the manufacturer's recommendations.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

#### 1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
    - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Engineer and Owner no fewer than 10 working days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Engineer and Owner's written permission.
3. Comply with NFPA 70E.

#### 1.11 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

#### 1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Enclosures: See Plan Sheet Panel Schedule for Enclosure Types and Mounting.
  1. Provide rated enclosures as shown below unless otherwise indicated on plans:
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Indoor Damp or Wet Locations: NEMA 250, Type 4X.
    - c. Indoor Corrosive Locations: NEMA 250, Type 4X Fiberglass
    - d. Outdoor Locations: NEMA 250, Type 4X
    - e. Wash-Down Areas: NEMA 250, Type 4X 316 stainless steel
    - f. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
    - g. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
    - h. For conditions not addressed above, provide rated enclosures for environmental conditions at installed locations.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  6. Finishes:
    - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel unless indicated otherwise on panel schedule.
    - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components. (Only required with the relative humidity is above 90% and the electrical room or space is not conditioned.)
  7. Directory Card: Inside panelboard door, mounted in transparent card holder. All breaker text to be typed and dated. Directory card shall include the source of supply to the panelboard Directory card shall include typed contact information for the electrical contractor
- C. Incoming Mains Location: Top or bottom per contractors installation method unless specifically indicated on the drawings.
- D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  4. Neutral Bus: 100% of the phase bus capacity unless otherwise indicated.
  5. Extra-Capacity Neutral Bus (when shown on the drawings): Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
  6. Split Bus: Vertical buses divided into individual vertical sections.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Main and Neutral Lugs Mechanical type.
  3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  5. Sub feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.



7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
8. >.

- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2]. Provide SPD devices per section 264313 of the project documents.

## 2.3 DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: As shown on the drawings
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

- G. Branch Overcurrent Protective Devices: Fused switches.

## 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains as shown on the drawings
- D. Branch Overcurrent Protective Devices: ] Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Provide Door-in-Door Construction with concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

## 2.5 ELECTRONIC-GRADE PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Current Technology; a subsidiary of Danahar Corporation.
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 4. Liebert Corporation.
  - 5. Siemens Energy & Automation, Inc.
  - 6. Square D; a brand of Schneider Electric.
  - 7.
- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 after installing SPD.
- C. Doors: Provide Door-in-Door Construction with Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

## 2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. >.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
  - a. Instantaneous trip.
  - b. Long- and short-time pickup levels.
  - c. Long- and short-time time adjustments.
  - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - d. Ground-Fault Protection: Integrally mounted or Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - e. Communication Capability: as shown on the controls drawings when specifically indicated.
  - f. Shunt Trip: as shown on the drawings.

- g. Undervoltage Trip, as shown on the drawings.
  - h. Auxiliary Contacts: Where shown on the drawings, two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
  - i. Alarm Switch: Where shown on the drawings, single-pole, normally open contact that actuates only when circuit breaker trips.
  - j. Key Interlock Kit: Where shown on the drawings, externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - k. Zone-Selective Interlocking: Where shown on the drawings, integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
  - l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
  - m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
  - n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- 1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
  - 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
  - 3. Auxiliary Contacts: When shown on the drawings provide Two normally open and normally closed contact(s) that operate with switch handle operation.

## 2.7 ACCESSORY COMPONENTS AND FEATURES (if call for on the contract drawings)

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Equipment Mounting:
- C. Floor Mounted panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete in the project specifications. If no concrete is specified use 3000 psi.
  - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
  - b. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - d. Install anchor bolts to elevations required for proper attachment to panelboards.
  - e. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- 2. Wall/Rack Mounted:
  - a. Mount to wall/rack using unistrut with bolts/mounting hardware approved by the structural engineer or architect.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- E. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- F. Mount panelboards such that the highest operator is less than 78" above finished floor.
- G. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- H. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- I. Install filler plates in unused spaces.
- J. Stub a minimum of four 1-inch (27-GRC) empty conduits but not less than 25% of the combined cross-sectional area of the all other live conduit from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub a

minimum of four 1-inch (27-GRC) empty conduits but not less than 25% of the combined cross-sectional area of the all other live conduit into raised floor space or below slab not on grade. This is for recessed panelboards only.

- K. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- L. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
  - c. Instruments and Equipment:
    - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in the "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
  1. Measure as directed during period of normal system loading.
  2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

### 3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Standard-grade receptacles, 125 V, **20** A.
2. GFCI receptacles, 125 V, 20 A.
3. Hospital-grade receptacles, 125 V, 20 A.
4. Hazardous (classified) location receptacles.
5. Twist-locking receptacles.
6. Pendant cord-connector devices.
7. Cord and plug sets.
8. Toggle switches, 120/277 V, [**15**] [**20**] A.
9. Decorator-style devices, [**15**] [**20**] A.
10. Occupancy sensors.
11. Digital timer light switches.
12. Residential devices.
13. Wall-box dimmers.
14. Wall plates.
15. Floor service fittings.
16. Poke-through assemblies.
17. Prefabricated multioutlet assemblies.
18. Service poles.

#### 1.3 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.



#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Service/Power Poles: **One for every 10**, but no fewer than **one**.
  - 2. Floor Service-Outlet Assemblies: **One for every 10**, but no fewer than **one**.
  - 3. Poke-Through, Fire-Rated Closure Plugs: **One for every 10**, but no fewer than **one**.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1. Light switches:
    - a. Hubbell.
    - b. Slater.
    - c. P&S.
    - d. Arrow Hart.
    - e. General Electric.
    - f. Leviton.
  - 2. Hazardous Area light switches:
    - a. Crouse-Hinds.
    - b. Appleton Electric Co.
    - c. Killark.

## 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with requirements in this Section.
- F. Devices for Owner-Furnished Equipment:
  - 1. Receptacles: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.
- G. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: **selected by Architect** unless otherwise indicated or required by NFPA 70 or device listing.
- H. Wall Plate Color: For plastic covers, match device color.
- I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.3 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 A :
  - 1. Description: Two pole, three wire, and self-grounding.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498 and FS W-C-596.
- B. Isolated-Ground Duplex Receptacles, 125 V, 20 A :
  - 1. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498 and FS W-C-596.
- C. Tamper-Resistant Duplex Receptacles, 125 V, 20 A :

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.
4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

D. Weather-Resistant Duplex Receptacle, 125 V, 20 A :

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

E. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A :

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.4 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A :

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: **Feed** through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A :

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A :

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Type: Feed through.
4. Standards: Comply with UL 498 and UL 943 Class A.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

## 2.5 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Receptacles, 120 V, 20 A :
  1. Configuration: NEMA WD 6, Configuration L5-20R.
  2. Standards: Comply with UL 498.
- B. Twist-Lock, Single Receptacles, 120 V, 30 A :
  1. Configuration: NEMA WD 6, Configuration L5-30R.
  2. Standards: Comply with UL 498.
- C. Twist-Lock, Single Receptacles, 250 V, 20 A :
  1. Configuration: NEMA WD 6, Configuration L6-20R.
  2. Standards: Comply with UL 498.
- D. Twist-Lock, Single Receptacles, 250 V, 30 A :
  1. Configuration: NEMA WD 6, Configuration L6-30R.
  2. Standards: Comply with UL 498.
- E. Twist-Lock, Single Receptacles, 277 V, 20 A :
  1. Configuration: NEMA WD 6, Configuration L7-20R.
  2. Standards: Comply with UL 498.

## 2.6 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.
- B. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.
- C. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
- D. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.
- E. Standards: Comply with FS W-C-596.

## 2.7 CORD AND PLUG SETS

- A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
- B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
- C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## 2.8 TOGGLE SWITCHES, 120/277 V, 20 A

- A. Single-Pole Switches, 120/277 V, 20 A :
  - 1. Standards: Comply with UL 20 and FS W-S-896.
- B. Antimicrobial, Single-Pole Switches, 120/277 V, 20 A :
  - 1. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
  - 2. Standards: Comply with UL 20 and FS W-S-896.
- C. Two-Pole Switches, 120/277 V, 20 A :
  - 1. Comply with UL 20 and FS W-S-896.
- D. Three-Way Switches, 120/277 V, 20 A :
  - 1. Comply with UL 20 and FS W-S-896.
  - 2.

## 2.9 OCCUPANCY SENSORS

- A. Wall Switch Sensor Light Switch, Dual Technology :
  - 1. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology.
  - 2. Standards: Comply with UL 20.
  - 3. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
  - 4. Adjustable time delay of **20** minutes.
  - 5. Able to be locked to **Manual-On** mode.
  - 6. Automatic Light-Level Sensor: Adjustable from **2 to 200 fc (21.5 to 2152 lux)**.

## 2.10 TIMER LIGHT SWITCH

- A. Digital Timer Light Switch :

1. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in [10] [20]-minute increments.
2. Standards: Comply with UL 20.
3. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
4. Integral relay for connection to BAS.

## 2.11 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.
  1. Plate-Securing Screws: Metal with head color to match plate finish.
  2. Material for Finished Spaces: [**Steel with white baked enamel, suitable for field painting**] [**Smooth, high-impact thermoplastic**] [**0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel**] [**0.04-inch- (1-mm-) thick, brushed brass with factory polymer finish**] [**0.05-inch- (1.2-mm-) thick, anodized aluminum**] [**0.04-inch- (1-mm-) thick steel with chrome-plated finish**].
  3. Material for Unfinished Spaces: [**Galvanized steel**] [**Smooth, high-impact thermoplastic**].
  4. Material for Damp Locations: [**Thermoplastic**] [**Cast aluminum**] with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant[, **die-cast aluminum**] [**thermoplastic**] with lockable cover.
- D. Antimicrobial Cover Plates:
  1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
  2. Tarnish resistant.

## 2.12 FLOOR SERVICE FITTINGS

- A. Flush-Type Floor Service Fittings:
  1. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
  2. Compartments: Barrier separates power from voice and data communication cabling.
  3. Service Plate and Cover: **Rectangular, solid brass** with satin finish.
  4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
  5. Data Communication Outlet: **Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable**

## 2.13 SERVICE POLES

### A. Dual-Channel Service Poles :

1. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
2. Poles: Nominal **2.5-inch- (65-mm-)** square cross-section, with height adequate to extend from floor to at least **6 inches (150 mm)** above ceiling, and with separate channels for power wiring and voice and data communication cabling.
3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
4. Material: **Aluminum**
5. Finishes: **Manufacturer's standard painted finish and trim combination**
6. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.
7. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
  4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.

- b. Straighten conductors that remain and remove corrosion and foreign matter.
- c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

- 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
- 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
- 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
- 4. Connect devices to branch circuits using pigtails that are not less than **6 inches (152 mm)** in length.
- 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
- 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
- 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
- 8. Tighten unused terminal screws on the device.
- 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

- 1. Install ground pin of vertically mounted receptacles **up**, and on horizontally mounted receptacles to the **right**.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

- 1. Install dimmers within terms of their listing.
- 2. Verify that dimmers used for fan-speed control are listed for that application.
- 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.



### 3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with **black** filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

### 3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections.
  - 1. Test Instruments: Use instruments that comply with UL 1436.
  - 2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Receptacles:
  - 1. Line Voltage: Acceptable range is 105 to 132 V.
  - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
  - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
  - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 262726

## SECTION 262813 – FUSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in control circuits enclosed switches switchboards enclosed controllers and motor-control centers.
  - 2. Spare-fuse cabinets.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse Coordination charts and tables and related data.
  - 5. Fuse sizes for elevator feeders and elevator disconnect switches.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Coordination charts and tables and related data.

#### 1.5 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than six of each size and type.

#### 1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

#### 1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### 1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littlefuse, Inc.

## 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

## 2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  2. Finish: Gray, baked enamel.
  3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
  4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
  1. Service Entrance: Per Approved Overcurrent Protection Study.
  2. Feeders: Per Approved Overcurrent Study

3. Motor Branch Circuits: Class RK5, time delay.
4. Other Branch Circuits: Per Approved Overcurrent Protection Study
5. Control Circuits: Class CC, fast acting.

### 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

### 3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Non-fusible switches.
  - 3. Molded-case circuit breakers (MCCBs).
  - 4. Molded-case switches.
  - 5. Enclosures.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details.

2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

## 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

## 1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to **10** percent of quantity installed for each size and type, but no fewer than six of each size and type.
2. Fuse Puller two for each size and type.

#### 1.9 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

#### 1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of electric service.
  2. Indicate method of providing temporary electric service.
  3. Do not proceed with interruption of electric service without Engineer and Owner's written permission.
  4. Comply with NFPA 70E.

#### 1.11 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels in accordance with NFPA 70.



## PART 2 - PRODUCTS

### 2.1 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. or approved equal
- B. Type HD, Heavy Duty, Single Throw, **600**-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses per the approved breaker coordination study or as specified, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, multi-pole, Single or Double Throw, **600**-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses per the approved breaker coordination study or as specified, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position when specifically shown on the drawings.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  4. Auxiliary Contact Kit: Where shown on the drawings, two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
  5. Hook stick Handle: Allows use of a hook stick to operate the handle.
  6. Lugs: Mechanical type, suitable for number, size, and conductor material.
  7. Service-Rated Switches: Labeled for use as service equipment.
  8. Accessory Control Power Voltage: As shown on the drawings.

### 2.2 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. or approved equal

- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Auxiliary Contact Kit: Where shown on the drawings, **two** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
  - 4. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
  - 6. Accessory Control Power Voltage: As shown on the drawings.

### 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. ABB
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 4. Siemens Energy & Automation, Inc.
  - 5. Square D; a brand of Schneider Electric.
  - 6. or approved equal.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and I<sup>2</sup>t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- J. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  - 5. Communication Capability (when specifically shown on the controls drawings): Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
  - 6. Shunt Trip (When specifically shown on the on line diagram): Trip coil energized from separate circuit, with coil-clearing contact.
  - 7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - 8. Auxiliary Contacts: (When shown on the drawings) two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - 9. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.
  - 10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - 11. Zone-Selective Interlocking: Integral with electronic ground-fault trip unit; for interlocking ground-fault protection function.
  - 12. Electrical Operator: Provide remote control for on, off, and reset operations.
  - 13. Accessory Control Power Voltage: Integrally mounted, self-powered As shown on the drawings.

## 2.4 MOLDED-CASE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. ABB
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

4. Siemens Energy & Automation, Inc.
  5. Square D; a brand of Schneider Electric.
  6. or approved equal
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
1. Standard frame sizes and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  4. Shunt Trip (When specifically shown on the drawings): Trip coil energized from separate circuit, with coil-clearing contact.
  5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  6. Auxiliary Contacts: (When shown on the drawings) two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
  7. Alarm Switch: One NC contact (When shown on the drawings.) that operates only when switch has tripped.
  8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
  9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
  10. Electrical Operator: Provide remote control for on, off, and reset operations.
  11. Accessory Control Power Voltage: Integrally mounted, self-powered As shown on the drawings.

## 2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 4X Stainless Steel unless specifically indicated otherwise on the drawings.
  3. Indoor damp, wet, corrosive areas: NEMA 250, Type 4X, non metallic enclosure
  4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  5. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION 262816

## SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. Related Requirements:
  - 1. Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. EMI: Electromagnetic interference.
- C. LED: Light-emitting diode.
- D. NC: Normally closed.
- E. NO: Normally open.
- F. OCPD: Overcurrent protective device.
- G. PID: Control action, proportional plus integral plus derivative.
- H. RFI: Radio-frequency interference.
- I. VFC/VFD/AFD: Variable-frequency motor controller.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
  - 1. Include dimensions and finishes for VFCs.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Include data and calculations to support the minimum SCCR specified.

- B. Shop Drawings: For each VFC indicated.
  - 1. Include mounting and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Include marking data per NEC 70, Article 409.110

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Required working clearances and required area above and around VFCs.
  - 2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
  - 3. Show support locations, type of support, and weight on each support.
  - 4. Indicate field measurements.
- B. Seismic Qualification Certificates: For each VFC, accessories, and components, from manufacturer.
  - 1. Certificate of compliance.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.
- C. Product Certificates: For each VFC from manufacturer.
- D. Harmonic Analysis Study and Report: Comply with IEEE 519 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering and active correction to limit TDD and THD(V) at the defined PCC to specified levels
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.



1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
  - b. Manufacturer's written instructions for setting field-adjustable overload relays.
  - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
  - d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
  - e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
  - f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than six of each size and type.
  3. Indicating Lights: Two of each type and color installed.
  4. Auxiliary Contacts: Furnish Two spare(s) for each size and type of magnetic controller installed.
  5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
  1. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Business Unit.
  2. Rockwell Automation, Inc; Allen-Bradley Brand.
  3. Schneider Electric USA, Inc.
  4. Siemens Energy & Automation, Inc.

### 2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:
  1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 409 and UL 508A, .
- B. Application: VFCs shall be variable torque unless otherwise indicated on the drawings.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
  1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1
  2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating:
  1. Variable Torque: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
  2. Constant Torque (if indicated on the drawings): Three phase; 10 to 66 Hz, with torque constant as speed changes maximum voltage equals input voltage.
- F. Unit Operating Requirements:
  1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding 5 percent.
  3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
  4. Minimum Efficiency: 97 percent at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
  6. Minimum Short-Circuit Current (Withstand) Rating: [to match the AIC of the servicing over current device.
  7. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
  8. Humidity Rating: Less than 95 percent (noncondensing).
  9. Altitude Rating: Not exceeding 3300 feet (1000 m).
  10. Vibration Withstand: Comply with NEMA ICS 61800-2.
  11. Overload Capability: 1.1 (variable torque) or 1.5 (constant torque) times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
  13. Speed Regulation: Plus, or minus 5 percent.
  14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
  15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
  2. Maximum Speed: 80 to 100 percent of maximum rpm.
  3. Acceleration: 0.1 to 999.9seconds.
  4. Deceleration: 0.1 to 999.9 seconds.
  5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Surge Suppression: Field-or Factory mounted surge suppressors UL 1449 SPD, Type 2 (installed when shown on the One Line Diagram).
  2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
  3. Under- and overvoltage trips.
  4. Inverter overcurrent trips.
  5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  6. Critical frequency rejection, with three selectable, adjustable deadbands.
  7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  8. Loss-of-phase protection.
  9. Reverse-phase protection.
  10. Short-circuit protection.

11. Motor-overtemperature fault.

- K. Automatic Reset/Restart: The drive shall be configured such that it automatically resets on return of power after a power loss. In addition, the drive shall be configured for manual reset of faults from the fault reset pushbutton or remotely from the control system. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Auto speed Search" feature is available and engaged.
- L. Bidirectional Auto speed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- N. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- O. Integral Input Disconnecting Means and OCPD: UL 489, molded-case switch, with power fuse block and current-limiting fuses with pad-lockable, door-mounted handle mechanism.
  - 1. Disconnect Rating: Not less than 125 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
  - 2. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
  - 3. [NC] [NO] alarm contact that operates only when circuit breaker has tripped.

## 2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

## 2.4 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions (lights to have a push to test function):
  - 1. Run (Red).
  - 2. Stop (Green)
  - 3. Fault (Amber)
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
- C. Provide a HAND –OFF – AUTO selector switch for each VFC, and manual speed pot for controlling the VFCs speed when operating in HAND.

- D. Historical Logging Information and Displays:
  - 1. Total run time.
  - 2. Fault log, maintaining last four faults with time and date stamp for each.
- E. Control Signal Interfaces:
  - 1. Electric Input Signal Interface:
    - a. A minimum of two programmable analog inputs: 4- to 20-mA dc
    - b. A minimum of six multifunction programmable digital inputs.
  - 2. Output Signal Interface: A minimum of one programmable analog output signal(s) 4- to 20-mA dc, which can be configured for any of the following:
    - a. Output frequency (Hz).
  - 3. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - a. Motor running.
    - b. Fault and warning indication (overtemperature or overcurrent)
- F. Facility Control System Interface: Factory-installed hardware and software shall interface with Facility Control System to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
  - 1. Communication Interface: Comply with Industrial Ethernet

## 2.5 LINE CONDITIONING AND FILTERING

- 1. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering & active harmonic correction, as required, to limit total harmonic distortion at the defined point of common coupling to meet IEEE 519 recommendations. The VFC manufacture shall also provide all required filtering and active harmonic correction equipment to guarantee that the VFCs will operate on the Emergency Generator System (as shown on the One Line Diagram). On projects that have an Emergency Generator, the point of common coupling shall be defined as the generator transfer switch.
  - 2. As a minimum all drives shall be provided with a 5%-line reactor. The 5% reactor may be removed for 18 pulse drives and LC filters.
  - 3. On projects without an Emergency Generator, the point of common coupling shall be defined as the secondary side of the Utility Company Transformer.
  - 4. On projects where there are existing VFCs, the point of common coupling shall be the primary side of the switchboard, panelboard, or MCC that serves the VFC.
- B. Output Filtering: Provide Output Filtering per the VFC manufacturer's recommendations based on the motor lead lengths. Output filtering is required on all motor leads greater than 150 ft.

2.6 BYPASS SYSTEMS (REQUIRED ONLY WHEN SHOWN ON THE "ONE LINE DIAGRAM)

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.
- C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
  - 1. Bypass Contactor: Load-break, NEMA-rated contactor.
  - 2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
  - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- D. Bypass Contactor Configuration: Reduced voltage soft start for all motors 50 hp and larger.
  - 1. NORMAL/BYPASS selector switch.
  - 2. HAND/OFF/AUTO selector switch.
  - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
  - 4. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - 5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
  - 6. Overload Relays: NEMA ICS 2.
    - a. Solid-State Overload Relays:
      - 1) Switch or dial selectable for motor-running overload protection.

- 2) Sensors in each phase.
  - 3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- b. NC & NO isolated overload alarm contact.
  - c. External overload, reset push button.

## 2.7 OPTIONAL FEATURES

- A. Motor Heater Contactor and CPT: Provide a Size 00 NEMA motor starter and a CPT sized to provide power for the motor heater. Motor heater circuit shall be interlocked to prevent operation when the drive is running.
- B. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- C. Remote digital operator kit, located on the exterior of the drive enclosure
- D. Communication Port: Ethernet.

## 2.8 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
  1. Dry and Clean Indoor Locations: Type 1
  2. Outdoor Locations: Type 4X stainless steel with integral AC units.
  3. Wet Areas: Type 4Xstainless steel with integral AC units.
  4. Other Wet or Damp Indoor Locations: Type 4X stainless steel with integral AC units
  5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

## 2.9 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
  1. Push Buttons: Unguarded.
  2. Pilot Lights: Push to test, and LED
  3. All pilot devices to be 30 mm, heavy duty, oil tight (housing to match VFC enclosure)
  4. Selector Switches: Rotary type.
  5. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Reversible NC/NO bypass contactor auxiliary contact(s).

- C. Cooling Fan and Exhaust System: For NEMA 250, NEMA 1 UL 508 component recognized: Supply fan, with intake and exhaust grills and filters 120 -V ac; obtained from integral CPT. (Provide thermostat control or interlock with drive operation)
- D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- E. Spare control-wiring terminal blocks; wired.

## 2.10 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
  - 1. Test each VFC while connected to its specified motor
  - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."



- B. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
  - 1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
  - 2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."
- D. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems(if this specification is not included in then no Seismic Bracing is required)".
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- F. Install fuses in each fusible-switch VFC.
- G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- J. Comply with NECA 1.

### 3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's -control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.

- C. Connect selector switches and other automatic-control devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
  - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

### 3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each VFC with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

### 3.5 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Tests and Inspections:
  - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify [Engineer before starting the motor(s)].
  - 5. Test each motor for proper phase rotation.
  - 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
  - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. VFCs will be considered defective if they do not pass tests and inspections.
- D. Perform Harmonic Distortion Testing at the point of common coupling defined in this specification and verify compliance with IEEE 519 guidelines.
- E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
- 3.6 STARTUP SERVICE
- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
- 3.7 ADJUSTING
- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device Coordination Study."
- 3.8 PROTECTION
- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

## SECTION 263213 - ENGINE GENERATORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency systems legally required standby systems, and optional standby systems power supply with the following features:
  - 1. Natural Gas or Diesel engine.
  - 2. Unit-mounted cooling system.
  - 3. Unit-mounted control and monitoring.
  - 4. Performance requirements for sensitive loads.
  - 5. Outdoor enclosure.
- B. Related Sections include the following:
  - 1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

#### 1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. LP: Liquid petroleum.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
  - 1. Thermal damage curve for generator.
  - 2. Sub-Transient Reactance.... ETC
  - 3. Time-current characteristic curves for generator protective device.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Dimensioned outline plan and elevation drawings of engine-generator set, and other components specified.
  - 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
  - 4. Wiring Diagrams: Power, signal, and control wiring.
  - 5. Generator Supplier shall submit a motor starting analysis based on the one-line diagram shown in the drawings.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification as required: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For installer, manufacturer, and testing agency.
- C. Source quality-control test reports.
  - 1. Certified summary of prototype-unit test report.
  - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
  - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
  - 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
  - 5. Report of sound generation.
  - 6. Report of exhaust emissions showing compliance with applicable regulations.
  - 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

- D. Field quality-control test reports.
- E. Warranty: as specified in this Section.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
  - 2. Verification that the fuel tank is full, following all tests and start-up procedures required under this contract.

#### 1.7 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering in a single container for storage and identified with labels describing contents.
  - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
  - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
  - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
  - 1. Maintenance Proximity: Not more than **four** hours' normal travel time from Installer's place of business to Project site.
  - 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

#### 1.9 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner and Engineer no fewer than ten working days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's or Engineer's written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - 1. Ambient Temperature Minus 15 to plus 40 deg C.
  - 2. Relative Humidity: 0 to 95 percent.
  - 3. Altitude: Sea level to 1000 feet (300 m)
- C. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:
  - 1. **High salt-dust content in the air due to sea-spray evaporation.**



#### 1.10 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators and other generator accessories as required. These items are specified in Section 077200 "Roof Accessories."

#### 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five-year warranty from date of Substantial Completion.

#### 1.12 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide Twelve months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
- B. Continuing Maintenance Service: Beginning at the conclusion of the Initial Maintenance service, provide forty-eight months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Caterpillar; Engine Div.
  - 2. Onan/Cummins Power Generation; Industrial Business Group.
  - 3. All request for substitutions shall be submitted before the deadline for question during the bid phase and approved via addendum prior to bidding

## 2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
- C. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated on the drawings.
  - 2. Output Connections: Three-phase, **four** wire.
  - 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of components.
- D. Generator-Set Performance:
  - 1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
    - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
  - 2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
  - 3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
  - 4. Steady-State Frequency Operational Bandwidth: Plus, or minus 0.25 percent of rated frequency from no load to full load.
  - 5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - 6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
  - 7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  - 8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
  - 9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
    - a. Provide permanent magnet excitation for power source to voltage regulator.
  - 10. Start Time: Comply with NFPA 110, Type 10, system requirements.

## 2.3 ENGINE

- A. Fuel: **Natural gas.**
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: The following items are mounted on engine or skid:
  - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
  - 1. Natural Gas System:
    - a. Carburetor.
    - b. Secondary Gas Regulators: One for each fuel type.
    - c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
    - d. Flexible Fuel Connectors: One for each fuel source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing provide an. Electronic as Required for Generator Paralleling when paralleling is required for the project.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
  - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.

- b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Provide a Muffler/Silencer designed to meet the sound requirements at the property line as defined by the local zoning. When noise requirements do not exist, provide a manufacturer's standard Critical type Silencer
  - a. If a manufacturer's standard Critical Silencer is provided, it must meet the following minimum requirements: Minimum sound attenuation of 25 dB at 500 Hz.
  - b. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85dBA or less.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: Provide the Manufacturer's Standard Battery Voltage either 12 or 24V, with negative ground.
  - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
  - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
  - 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
  - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
  - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
  - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
    - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 3R, wall-mounted cabinet.

## 2.4 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
  - 1. AC voltmeter.
  - 2. AC ammeter.
  - 3. AC frequency meter.
  - 4. DC voltmeter (alternator battery charging).
  - 5. Engine-coolant temperature gage.
  - 6. Engine lubricating-oil pressure gage.
  - 7. Running-time meter.
  - 8. Ammeter-voltmeter, phase-selector switch(es).
  - 9. Generator-voltage adjusting rheostat.
  - 10. Start-stop switch.
  - 11. Overspeed shutdown device.
  - 12. Coolant high-temperature shutdown device.
  - 13. Coolant low-level shutdown device.
  - 14. Oil low-pressure shutdown device.
  - 15. Fuel tank derangement alarm.
  - 16. Fuel tank high-level shutdown of fuel supply alarm.
  - 17. Generator overload.
- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

- E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."
- F. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
  - 1. Engine high-temperature shutdown.
  - 2. Lube-oil, low-pressure shutdown.
  - 3. Overspeed shutdown.
  - 4. Remote emergency-stop shutdown.
  - 5. Engine high temperature pre-alarm.
  - 6. Lube-oil, low-pressure pre-alarm.
  - 7. Fuel tank, low-fuel level.
  - 8. Low coolant level.
- G. Remote Alarm Annunciator (where shown on the drawings): Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- H. Remote Emergency-Stop Switch (when shown on the drawings): Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

## 2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
  - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
  - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
  - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
  2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
  3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
  4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

## 2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip proof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Sub-transient Reactance: 12 percent, maximum.
- L. Alternator Temp Rise: 130 degrees C maximum
- M. Size as shown on the drawings

## 2.7 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant per ASCE-7 and local building codes. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:
1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
  2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
  3. Louvers: Equipped with bird screen arranged to permit air circulation when engine is not running while excluding exterior birds, and rodents.
  4. Hinged Doors: With padlocking provisions.
  5. Ventilation: Louvers equipped with bird screen arranged to permit air circulation while excluding exterior birds, and rodents.
  6. Muffler Location: Within enclosure.
- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
  2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- D. Interior Lights with Switch: Factory-wired, vapor proof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
1. DC lighting system for operation

## 2.8 VIBRATION ISOLATION DEVICES

- A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.



5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.9 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## 2.10 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set, and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
  1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  2. Full load run.
  3. Maximum power.
  4. Voltage regulation.
  5. Transient and steady-state governing.
  6. Single-step load pickup.
  7. Safety shutdown.
  8. Report factory test results within 10 days of completion of test.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Section 232116 Hydronic Piping Specialties."
  - 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Section 232116 Hydronic Piping Specialties."
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- F. For generators located inside building, provide manufacturers standard insulation blanket to prevent the room from overheating.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
  - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - c. Verify acceptance of charge for each element of the battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
  - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  - 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
  - 7. Exhaust Emissions Test: Comply with applicable government test criteria.
  - 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
  - 9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
  - 10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and

discharge, at four locations on the property line, and compare measured levels with required values.

- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
  - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Section 017900 "Demonstration and Training."

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City Complex

END OF SECTION 263213

## SECTION 263600 - TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes transfer switches rated 600 V and less, including the following:
  - 1. Automatic transfer switches.
  - 2. Bypass/isolation switches.
  - 3. Manual transfer switches.
  - 4. Remote annunciation systems.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
  - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

#### 1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, manual transfer switches, and remote annunciators, through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

#### 1.7 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Engineers and Owner's written permission.

## 1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURED UNITS

#### A. Contactor Transfer Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a.
  - b. Caterpillar; Engine Div.
  - c. Emerson; ASCO Power Technologies, LP.
  - d. GE Zenith Controls.
  - e. Kohler Power Systems; Generator Division.
  - f. Onan/Cummins Power Generation; Industrial Business Group.
  - g. or Approved Equal.

#### B. Transfer Switches Using Molded-Case Switches or Circuit Breakers (When specifically shown on the drawings):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a.
  - b. Eaton Electrical Inc.; Cutler-Hammer.
  - c. GE Zenith Controls.
  - d. Caterpillar; Engine Div.
  - e. Emerson; ASCO Power Technologies, LP.
  - f. Kohler Power Systems; Generator Division.
  - g. Onan/Cummins Power Generation; Industrial Business Group.
  - h. or Approved Equal.

### 2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.



- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
  - 2. Switch Action: Double throw; mechanically held in both directions.
  - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- I. Oversize Neutral (when specifically shown on the one line diagram): Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- J. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater. (Heaters shall be powered from the load size of the switches. No external power sources shall be required. Fuses shall be provided per the NEC and UL.)
- K. Battery Charger: For generator starting batteries. (to be provided when a battery charger is not specifically provided in the generator enclosures.)
  - 1. Float type rated 2 A.
  - 2. Ammeter to display charging current.
  - 3. Fused ac inputs and dc outputs.

- L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 260553 "Identification for Electrical Systems."
  - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- N. Enclosures:
  - 1. Indoor NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
  - 2. Outdoor: NEMA 250, Type 4X Stainless Steel, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
  - 3.

## 2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- G. Automatic Closed-Transition Transfer Switches (When specifically call out on the one line diagram): Include the following functions and characteristics:
  - 1. Fully automatic make-before-break operation.
  - 2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100ms.

3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
    - a. Initiation occurs without active control of generator.
    - b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
  4. Failure of power source serving load initiates automatic break-before-make transfer.
- H. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- I. Automatic Transfer-Switch Features:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  5. Test Switch: Simulate normal-source failure.
  6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal-and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Dual Utility Source: Provide the ability to manually select the preferred utility source when the ATS is used to switch between two utilities.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
  - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - b. Push-button programming control with digital display of settings.
  - c. Integral battery operation of time switch when normal control power is not available.

#### 2.4 BYPASS/ISOLATION SWITCHES (When specifically shown on the drawings)

- A. Comply with requirements for Level 1 equipment according to NFPA 110.
- B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
  1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
  2. Draw out Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
  3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
  4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
  5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
  6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
  7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

- C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

## 2.5 MANUAL TRANSFER SWITCHES

- A. Operation: Manually transferring load in either direction with either or both sources energized.
- B. Double-Throw Switching Arrangement: Incapable of being connected to both sources at the same time during the switching process

## 2.6 REMOTE ANNUNCIATOR SYSTEM (When specifically shown on the drawings)

- A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
  - 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  - 2. Switch position.
  - 3. Switch in test mode.
  - 4. Failure of communication link.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
  - 1. Indicating Lights: Grouped for each transfer switch monitored.
  - 2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
  - 3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
  - 4. Lamp Test: Push-to-test or lamp-test switch on front panel.

## 2.7 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches nominal high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- D. Identify components according to Section 260553 "Identification for Electrical Systems."
- E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

### 3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Provide raceway to accommodate required wiring.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.
    - d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
  - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
  - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
  - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
  - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Prepare test and inspection reports.
- G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
  1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
  2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

END OF SECTION 263600



## SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes lightning protection for structures and buildings.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
  - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
  - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- B. Provide a certification, from the manufacturer of all roofing systems that the mounting method is approved by manufacturer of roofing material.
- C. Field quality-control reports.
- D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
  - 1. Ground rods.
  - 2. Ground loop conductor.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
  - 1. UL Master Label.
  - 2. LPI System Certificate.
  - 3. Provide a Recertification for any existing lighting protections system that the proposed system connects to.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

## 1.6 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

## PART 2 - PRODUCTS

### 2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class I or Class II depending on building height, copper unless otherwise indicated.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, or comparable product by one of the following:
    - a. East Coast Lightning Equipment Inc.
    - b. ERICO International Corporation.
    - c. Harger.
    - d. Heary Bros. Lightning Protection Co. Inc.
    - e. Independent Protection Co.
    - f. Preferred Lightning Protection.
    - g. Robbins Lightning, Inc.
    - h. Thompson Lightning Protection, Inc.
    - i. or Approved Equal

2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
  3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.
- C. Main and Bonding Conductors: Copper.
- D. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- E. Ground Rods: Copper-clad steel, sectional type; [3/4 inch (19 mm) in diameter by 10 feet (3 m) long.
- F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
1. System conductors.
  2. Down conductors.
  3. Interior conductors.
  4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- G. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.
- H. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than **24 inches (600 mm)** from building foundation.
2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

- I. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.
- J. Install a bond jumper between the building ground and the lightning protection Ground Loop. The bond jumper shall be a 4/0.

### 3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

### 3.4 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. Obtain one of the following labels:
  1. UL Inspection: Meet requirements to obtain a UL Master Label for system.
  2. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 264113

## SECTION 264313 - LOW-VOLTAGE SURGE PROTECTION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

#### 1.2 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Requirements:
  - 1. Section 262413 "Switchboards" for factory installed SPDs.
  - 2. Section 262416 "Panelboards" for factory installed SPDs.

#### 1.3 DEFINITIONS

- A.  $I_n$ : Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, In nominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

#### 1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion, including replacement.

#### 1.8 MANUFACTURERS

- A. Subject to compliance with requirements, **[provide products by one of the following]**:
  1. ABB France. (Current Technology)
  2. Advanced Protection Technologies Inc. (APT).
  3. Eaton Corporation, (Innovative Technology.)
  4. Emerson Electric Co. (Liebert)
  5. Schneider Electric Industries SAS.
  6. Siemens Industry, Inc.
  7. Surge Suppression, Inc
  8. Total Protection Solutions
  9. DEHN Inc.

### PART 2 - PRODUCTS

#### 2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

- C. . All Surge Protective Devices (SPDs) shall be tested and listed to the latest edition of ANSI/UL 1449-2006. “Manufactured in accordance with UL 1449” is not equivalent to being listed to ANSI/UL 1449-2006 and does not meet the intention of this specification
- D. MCOV of the SPD shall be the nominal system voltage.
- E. SPD units shall be UL 1283 Listed as an Electromagnetic Interference Filter and marked accordingly.
- F. Provide SPDs with the following modes of protection:
  - 1. Three-Phase, Four Wire systems: 10 Modes: L1-L2, L2-L3, L3-L1, L1-N, L2-N, L3-N, L1-G, L2-G, L3-G, N-G
  - 2. Three-Phase, Three Wire systems: 6 Modes: L1-L2, L2-L3, L3-L1, L1-G, L2-G, L3-G
  - 3. Single-Phase, Three Wire Systems: 6 Modes: L1-L2, L2-N, N-L1, L1-G, L2-G, N-G

## 2.2 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

- A. SPDs: Listed under UL 1449, Type 1.
  - 1. SPDs with the following features and accessories:
    - a. Integral disconnect switch and overcurrent protection.
    - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
    - c. Indicator light display for protection status.
    - d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
    - e. Digital Display Surge counter that counts the number of surges the device has experienced since installation.
    - f. Audible alarm
- B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- C. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V ,208Y/120 V or 240/120 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 & 240/120 V.
  - 2. Line to Ground: 1200 V for 480Y/277 V; 1200 V for 208Y/120 & 240/120 V.
  - 3. Line to Line: 2000 V for 480Y/277 V 1000 V for 208Y/120 & 240/120 V.
- D. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V.

2. Line to Ground: 1000
3. Line to Line: 1000 V.

- E. SCCR: Equal or exceed 200 kAIC.
- F. Nominal Discharge Current ( $I_n$ ) Rating: 20 kA.

### 2.3 SWITCHBOARD, PANELBOARD AND MCC SUPPRESSORS

- A. SPDs: Comply with UL 1449, Type 2.
1. Include LED indicator lights for power and protection status.
  2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status
- B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA <>. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- C. .
- D. Protection modes and UL 1449 VPR for grounded wye circuits with, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V & 240/120 V.
  2. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V & 240/120 V.
  3. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V & 240/120 V.
  4. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V & 240/120 V
- E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
1. Line to Neutral: 600V.
  2. Line to Ground: 600V.
  3. Neutral to Ground: 600V.
  4. Line to Line: 1000V.
- F. SCCR: Equal or exceed 100K AIC min or per the one-line diagram
- G. Nominal Discharge Current ( $I_n$ ) Rating: 20 kA
- H. Sinewave Tracking/Frequency Responsive Capability.
1. SPDs installed to protect Switchboards, Panelboards or MCCs serving sensitive electronic equipment shall utilize voltage independent, frequency responsive dedicated Sinewave Tracking circuitry to mitigate the effects of switching or ringing surges.
    - a. Sensitive Electronic Equipment shall include, but is not limited to:
      - 1) Variable Frequency Controllers



- 2) Lighting with Electronic Ballasts
2. EMI/RFI filtering specifically will not be considered as equal to sinewave tracking.
3. Devices with Sinewave Tracking circuitry shall be tested in accordance with the latest edition of IEEE C62.41.2 for a Category A Ring Wave (2000 volt – 67-amp ring wave)
  - a. The maximum amplitude shall be less than 50V peak deviation from the insertion point of the surge on the sine wave to the peak of the transient.

## 2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 4X.

## 2.5 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD. DO NOT WIRE DIRECT TO PANEL BUS
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
  1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 264313

## SECTION 265119 - LED INTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Provide all materials, equipment and perform all operations for complete installation of interior LED luminaires and related Work as indicated on the Drawings and specified herein, including but not limited to the following:

1. Interior Luminaires.
2. Emergency lighting units.
3. Exit signs.
4. Luminaire supports.

- B. Related Sections:

1. Division 26

#### 1.3 DEFINITIONS

- A. CCT: Correlated Color Temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire."
- E. IESNA: Illumination Engineering Society of North America
- F. IP: International Protection or Ingress Protection Rating.
- G. LED: Light-Emitting Diode.
- H. Lumen: Measured output of LED and luminaire, or both.
- I. Luminaire: Complete lighting unit, including LED, driver, reflector, and housing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Arrange in order of luminaire designation.
  2. Include data on features, accessories, and finishes.
  3. Include physical description and dimensions of luminaires.
  4. Include emergency lighting units, including batteries and chargers.
  5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for LED's and accessories identical to those indicated for the luminaire as applied in this Project.
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  7. Air and Thermal Performance Data: For air-handling luminaires. Furnish data required in "Action Submittals" Article in Section 233713 "Diffusers, Registers, and Grilles."
  8. Sound Performance Data: For air-handling luminaires. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
  2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.
- C. Samples: When requested by the engineer, provide a sample luminaire of each type and style including all specified options, mounting brackets, and accessories. Each Sample shall include the following:
1. LED's and drivers, installed.
  2. Cords and plugs.
  3. Pendant support system.
- D. Product Schedule: For luminaires, emergency lighting units, exit signs and LED's. Use same designations indicated on Drawings.
- E. Samples: Submit one complete operating unit for each type of luminaire specified, if requested by the Design Professional.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
  4. Structural members to which suspension systems for luminaires will be attached.
  5. Initial access modules for acoustical tile, including size and locations.
  6. Other items in finished ceiling, including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Ceiling-mounted projectors.
    - g. Occupancy sensors.
    - h. Smoke and Heat Detectors.
    - i. Fire alarm audible and visual devices.
    - j. Security sensors.
    - k. Cameras.
    - l. Wireless access points.
  7. Moldings.
- B. Calculations: Provide lighting calculations for all interior spaces in accordance with IESNA guidelines. All calculations shall be performed under the supervision of a person holding a PE registered in the state in which the project is being constructed. All calculations shall include all assumptions. All rooms shall have point to points with the following summaries per room: Max/Min, Ave/Min, and Average Illumination.
- a. The contractor shall call special attention to the engineer for any spaces that do not meet IESNA Guidelines.
- C. Qualification Data: For testing laboratory providing photometric data for luminaires.
- D. Product Certificates: For each type of luminaire.
- E. Sample of special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
1. Provide a list of all LED types used on Project; use ANSI and manufacturers' codes.

2. Provide luminance test results within each room that verify that the lighting calculation levels (fc) at the working plane have been achieved.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. LED Assembly: Five for every 100 of each type and rating installed. Furnish at least two of each type.
  2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  3. LED Driver: One for every 100 of each type and rating installed. Furnish at least two of each type.
  4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least two of each type.
  5. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least two of each type.

#### 1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products and complying with the applicable IES testing standards.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Manufacturer's Qualifications: Firms regularly engaged in manufacture of interior LED Luminaires of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.

#### 1.9 COORDINATION

- A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, partition assemblies and other items indicated in section 1.5.A.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver luminaires in factory-fabricated containers or wrappings, which properly protect luminaires from damage.
- B. Store luminaires in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground.
- C. Handle luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.
- D. All luminaires shall be protected from damage during the installation. Any damaged luminaires, diffusers, glassware, sockets, stems and the like, shall be replaced with new parts, without additional cost to the Owner.
- E. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires, emergency power units and exit signs that fail in materials or workmanship within one-year period from date of Substantial Completion.
- B. [Or]Manufacturer's Warranty: Five year(s) from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings.
  - 1. Substitutions:

2.2 LUMINAIRE GENERAL REQUIREMENTS

- A. It is the intent to provide and install a fully functional luminaire, and multiples thereof, on each and every outlet shown on the Drawings. Therefore, in the event a type designation is omitted from any luminaire indicated on the plans, provide units typical of those in similar locations within the scope of the project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Factory-Applied Labels: Comply with UL 1598 and the requirements of all authorities having jurisdiction. Include recommended LED assemblies and drivers. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when LED assemblies are in place.
  - 1. Label shall include the following LED characteristics:
    - a. "USE ONLY" and include specific LED type.
    - b. LED assembly dimensions, shape, size, wattage, and coating.
    - c. CCT and CRI.
- D. Recessed luminaires shall comply with NEMA LE 4.
- E. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- F. Luminaires installed in hazardous locations shall be suitable for the area classification class, division and group.
- G. Luminaires installed in corrosive locations shall be NEMA 4X rated.
- H. Luminaires installed in wet locations shall be NEMA 3R rated.
- I. Luminaires installed in damp locations shall be rated for damp location.
- J. Luminaires installed in washdown areas shall be sealed and gasketed.
- K. All luminaires shall be furnished complete with necessary devices and appurtenances to completely install luminaires in operating condition, including all hanging and supporting devices, plaster rings, studs, hickey, canopies, stems, clamps, leveling devices, glassware, etc.
- L. Nominal Operating Voltage: Operating Voltage for all luminaires shall be as indicated in Luminaire Schedule on the Drawings with a range of 108-132 volts for 120-volt circuits and 249-305 for 277-volt circuits.
- M. LED Drivers and Modules shall include the following features unless otherwise indicated:
  - 1. Light output lumens (lm) as indicated in the Luminaire Schedule.
  - 2. Minimum allowable efficacy of 80 lm/W.
  - 3. CRI: Minimum 85: As indicated on Luminaire Schedule.
  - 4. CCT of maximum of 4000 K: As indicated on Luminaire Schedule.
  - 5. Rated LED life of minimum 50,000 hours per IES L70.
  - 6. Dimmable from 100 percent to 5 percent of maximum light output.
  - 7. Internal LED driver.
  - 8. User-Replaceable LED assembly's:
  - 9. Minimum efficiency: 90% at half and full load.
  - 10. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
  - 11. Integral short circuit, open circuit, and overload protection.
  - 12. Power Factor ≥ 0.85 at 50% load and ≥.90 at full load.
  - 13. Total Harmonic Distortion: ≤ 20% at 50% load and ≤15% at 100% load.
  - 14. Comply with FCC 47 CFR Part 15.



- N. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit replacing LED assembly's without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during replacing LED assembly's and when secured in operating position.

### 2.3 GENERAL REQUIREMENTS FOR EMERGENCY LUMINAIRES

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.

### 2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  - 1. AC Operation: LED's, 50,000 hours minimum rated life.
  - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes LED from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects LED's from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

### 2.5 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns LED on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. LED automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects LED's from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects LED heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.6 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 TEMPORARY LIGHTING

- A. If approved by the Owner's representative, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

### 3.3 INSTALLATION

- A. Provide a label on each luminaire outlet shown on the Drawings, the type of luminaire indicated and as specified in the "Luminaire Schedule" on the Drawings.
- B. Each room/area shall have its luminaires controlled from a local switch for each circuit serving the room, where not controlled by an occupancy sensor. Provide local toggle switches so that all luminaires can be locally controlled, whether or not the switches are shown on the Drawings.
- C. Install interior luminaires at locations and heights as indicated on the Drawings and in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that luminaires fulfill requirements.
- D. Coordinate construction and design of trim and supports for all stem mounted and recessed luminaires for conformity with ceilings in which the units are installed. Any special Work that may be required to overcome unusual difficulties in fitting the luminaire designs to particular locations, or to clear unforeseen obstacles, etc., shall be done without extra cost to the Owner.
- E. Support all recessed luminaires, other than downlights from at least two diametrically opposite corners, independent of the ceiling structural system and directly to the building slab and/or primary structural steel. Fasten luminaires securely at all other points to the ceiling structural system. Do not fasten to any trades other than those indicated.

- F. Securely support downlights from at least two points on the ceiling structural system. Do not fasten to other trades other than the ceiling structural system trade.
- G. Support all surface and pendent luminaires independently of the ceiling structural system and directly to the building slab and/or primary structural steel. Provide pendant/surface fixtures longer than 2 feet with two hangers. Fasten luminaires securely at all other points to the ceiling structural system. Do not fasten to any trades other than those indicated. Ensure that pendant luminaires are plumb and level. Provide stem hanger with ball aligners and provisions for minimum one-inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.
- H. Attach wall-mounted luminaires to structural members in walls. Do not attach luminaires directly to gypsum board.
- I. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- J. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and replacing LED assembly.
  - 3. Provide support for luminaire without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
  - 5. Sized and rated for luminaire and emergency power unit weight.
  - 6. Able to maintain luminaire position when testing emergency power unit.
- K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.

- C. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Upon completion of installation of interior luminaires, emergency power units and exit signs, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

### 3.7 EMERGENCY POWER UNIT AND EXIT SIGN CHARGING

- A. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
- B. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

### 3.8 CLEANING

- A. Clean interior lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.
- B. Protect installed fixtures from damage during remainder of construction period.

### 3.9 ADJUSTMENTS

- A. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Provide up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  - 1. During adjustment visits, inspect all luminaires. Replace LED assembly's, LED drivers, luminaires emergency power units, batteries and exit signs, that are defective.
  - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 3. Adjust the aim of luminaires in the presence of the Owner's representative.

END OF SECTION 265119

***DIVISION 27***  
***COMMUNICATIONS***

SECTION 271500 – COMMUNICATIONS CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Specifications for instrumentation cables
- B. Specifications for ProfiNet cables
- C. Specifications for ethernet cables
- D. Specification for optical fiber cables.

1.03 CITED STANDARDS

- A. National Fire Protection Association (NFPA):
  - 1. 70, National Electrical Code (NEC)
  - 2. 70E Standard for Electrical Safety in the Workplace 2012
- B. The Institute of Electrical and Electronics Engineers (IEEE)
- C. International Society of Automation (ISA)
- D. Telecommunications Industry Association (TIA)
- E. Underwriters Laboratory (UL)
- F. Insulated Cable Engineers Association (ICEA)
- G. ProfiNet / ProfiBus Users Organizations

1.04 QUALITY CONTROL

- A. The CONTRACTOR shall inspect all materials in the field for compliance with Contract requirements prior to compliance testing with the ENGINEER.
- B. The CONTRACTOR shall demonstrate, to the satisfaction of the Owner's ENGINEER, that materials meet the intent of the Contract Documents.
- C. The Integrator shall remove or replace any materials or programming that do not comply with the Contract Documents.
- D. All test equipment shall be calibrated in accordance with the manufacturer's written documentation. The CONTRACTOR shall provide acceptable proof of calibration with all test reports.

1.05 ACTION SUBMITTALS

- A. Submit in accordance with Section 01300:
  - 1. Product data: for each type of product.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.
- C. Standard Test Record Sheets.

#### 1.07 ABBREVIATIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. LAN: Local area network.
- E. RCDD: Registered Communications Distribution Designer.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Furnish network media products as indicated in the contract drawings and specifications.
- B. All products shall meet all requirements stated in this specification.

#### 2.02 INSTRUMENTATION CABLE

- A. Manufacturers:
  - 1. Belden.
  - 2. Or approved equal.
- B. Flame Rating: LSZH
- C. Analog Control Cable
  - 1. Analog signal cable (4-20 mA) shall be 18-gauge twisted shielded single pair tinned copper stranded conductors.
  - 2. The pair shall have a minimum lay of 2 inches per twist.
  - 3. The shield shall be aluminum-polyester with a 20 AWG stranded tinned copper drain wire and an overall Teflon jacket rated at 300 volts.
  - 4. Color code shall be red and black.
  - 5. Cable shall be suitable for plenum, conduit and submerged service.
  - 6. Shields shall be properly grounded at each end.



- D. Discrete Signal Wire
  - 1. Soft drawn copper conforming to ASTM Standard B-3.
  - 2. All wire shall be single conductor type unless otherwise indicated.
  - 3. All wire shall be stranded in accordance with ASTM Standard B-8.
  - 4. Instrumentation discrete signal wire shall be a minimum of #14 AWG.
  - 5. Wiring within the panels shall be a minimum of #16 AWG.

## 2.03 ETHERNET COMMUNICATION

- A. Manufacturers:
  - a. Belden.
  - b. Or Engineer Approved Equal. All request for substitutions shall be submitted with complete and thorough documentation of equivalency and submitted for approval no less than two weeks prior to bidding.
- B. Description: CAT 6, 22awg, UTP (unshielded twisted pair) manufactured in accordance ANSI/TIA/EIA-568-B.2 and ANSI/ICEA S-80-576
- C. Ethernet network isolators are required on all ethernet networks.

## 2.04 OPTICAL FIBER CABLE

- D. Manufacturers:
  - 1. Belden
  - 2. Corning
  - 3. Or Engineer Approved Equal. All request for substitutions shall be submitted with complete and thorough documentation of equivalency and submitted for approval no less than two weeks prior to bidding.
- E. Description: Multimode, 62.5/125 micrometer, 6 count minimum, nonconductive, tight buffer, optical fiber cable.
  - 1. Comply with ICEA S-83-596 for mechanical properties.
  - 2. Comply with TIA/EIA-568-B.3 for performance specifications.
  - 3. Comply with TIA-492AAAA-A for detailed specifications.
  - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
    - a. General Purpose, Nonconductive: Type OFN or OFNG
    - b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    - c. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
  - 5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
  - 6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- F. Jacket:
  - 1. Jacket Color:
    - a. Orange for 62.5/125-micrometer cable.
  - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
  - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

- G. Fiber optic connectors shall be ST type unless otherwise noted.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide all labor, materials, field-test instruments and equipment required to complete the installation, testing and commissioning of the required Network Media in accordance with the contract documents
- B. In order to conform to the overall project schedule, the CONTRACTOR shall survey the work area and coordinate cable testing with the other applicable trades.

END OF SECTION

***DIVISION 32***

***EXTERIOR IMPROVEMENTS***

## SECTION 323113 - CHAIN LINK FENCES AND GATES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Chain-link fence enclosures with vinyl coating.
  2. Gates: swing type with vinyl coating.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
1. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 12 feet high and post spacing not to exceed 10 feet.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
1. Fence and gate posts, rails, and fittings.
  2. Chain-link fabric, reinforcements, and attachments.
  3. Gates and hardware.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.4 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on

Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

## 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
1. Fabric Height: 72 inches.
  2. Steel Wire Fabric: Wire with a diameter of **0.192 inch**.
    - a. Mesh Size: 2 inches.
    - b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied before leaving.
    - c. Fabric/Vinyl Coated Steel: Chain link fence fabric shall be galvanized steel wire with a continuously bonded vinyl coating, with a finish size (i.e., size after coating) of 8 gauge, and shall comply with ASTM F 668.

### 2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:
1. Fence Height: 72 inches.
  2. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40.
  3. Horizontal Framework Members: top rails complying with ASTM F 1043.
  4. Brace Rails: Comply with ASTM F 1043.
  5. Metallic Coating for Steel Framing:

- a. Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film with outer vinyl coating.

## 2.3 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
  1. Type II, zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:
    - a. Matching chain-link fabric coating weight.

## 2.4 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and double swing gate types.
  1. Gate Leaf Width: 5 M.
  2. Gate Fabric Height: 72 inches or less.
- B. Pipe and Tubing:
  1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
  2. Gate Posts: Round tubular steel.
  3. Gate Frames and Bracing: Round tubular steel.
- C. Hardware:
  1. Hinges: 180-degree outward swing.
  2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
  3. Rollers: Provide at toe of gates to prevent gate sagging.
  4. Cane Bolt: Provide at inactive leaf.

## 2.5 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Post Caps: Provide for each post.
  1. Provide line post caps with loop to receive tension wire or top rail.
- C. Post Bottom Brackets: Provide for each post.

1. Provide brackets with flanges with 2 holes for bolting to floor.
- D. Rail and Brace Ends: For each gate, corner, pull, and end post.
- E. Rail Fittings: Provide the following:
  1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
  2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate rails in the fence line-to-line posts.
- F. Tension and Brace Bands: Pressed steel.
- G. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- H. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- I. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
  1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
    - a. Hot-Dip Galvanized Steel: 0.148-inch- diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.
- J. Finish:
  1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc with outer vinyl coating.

## 2.6 VINYL COATING

- a. The vinyl coating shall conform to FS RR-F-191/1C.
- b. Colors shall be stabilized and shall have a light fastness to withstand a minimum Weather-O-Meter exposure of at least 1500 hours without deterioration when tested in accordance with ASTM D 1499.
- c. Specific gravity shall be between 1.26 and 1.30 in accordance with ASTM D 792.
- d. Hardness shall be A90 +/-5 in accordance with ASTM D 2240.
- e. Tensile strength shall be between 2600 and 3000 psi (17.94 MPa and 20.7 MPa) in accordance with ASTM D 412.
- f. Vinyl coating shall be exposure-resistant to dilute solutions of most common mineral acids, sea water, salts, and alkali.

- g. Vinyl coating shall be continuously bonded to the wire under 5000 psi (34.5 MPa) pressure before the wire is woven into fabric.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

#### 3.2 CHAIN-LINK FENCE INSTALLATION

- A. Post Setting: Set posts with mechanical anchors at indicated spacing.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing.
- B. Terminal Posts: Locate corner, and gate posts per ASTM F 567.
- C. Line Posts: Space line posts uniformly at 96 inches o.c.
- D. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
  - 1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- E. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
  - 1. Extended along bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
- F. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- G. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.



- H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
- I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
  - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

### 3.3 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

### 3.4 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

END OF SECTION 323113

## SECTION 328400 PLANTING IRRIGATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Piping.
2. Manual valves.
3. Automatic control valves.
4. Miscellaneous piping specialties.
5. Sprinklers.
6. Drip irrigation specialties.
7. Controllers.
8. Boxes for automatic control valves.

#### 1.3 DEFINITIONS

- A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
- B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.
- C. Main Piping: Downstream from point of connection to water distribution piping to, and including control valves. Piping is under water-distribution-system pressure.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with controller valves.
- B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.
- C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
  1. Irrigation Main Piping: **200 psig**
  2. Circuit Piping: **150 psig**

### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Irrigation systems, drawn to scale, on which components are shown and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions such as signs and light standards.
- B. Zoning Chart: Show each irrigation zone and its control valve.
- C. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- D. Field quality-control reports.

### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sprinklers, drip, controllers, and automatic control valves to include in operation and maintenance manuals.

### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers that include a certified irrigation designer qualified by The Irrigation Association or Professional Class member of the American Society of Irrigation Consultants
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

- B. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedules 40 and 80.
  - 1. PVC Socket Fittings: ASTM D 2466, Schedules 40 and 80.
  - 2. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
  - 3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.
  
- C. PVC Pipe, Pressure Rated: ASTM D 2241, PVC 1120 compound, SDR 21 and SDR 26.
  - 1. PVC Socket Fittings: ASTM D 2467, Schedule 80.
  - 2. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.

## 2.2 PIPING JOINING MATERIALS

- A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 6q56.
  
- B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.3 ENCASUREMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.

## 2.4 MANUAL VALVES

- A. Plastic Ball Valves:
  - 1. Description:
    - a. Standard: MSS SP-122.
    - b. Pressure Rating: 150 psig
    - c. Body Material: PVC.
    - d. Type: Union.
    - e. End Connections: Socket or threaded.
    - f. Port: Full.

## 2.5 AUTOMATIC CONTROL VALVES

- A. Plastic Automatic Control Valve
  - 1. General Information
    - a. Provide valve as per the specification.
  
  - 2. Valve
    - a. Irrigation valve specifications include but are not limited to:
      - 1) The valve body and bonnet shall be constructed of heavy-duty and ultra-violet resistant plastic.

- 2) The bonnet shall be assembled to the body using multi-drive screws for use with flathead, Phillips, or hexagonal tools.
- 3) Shall possess a water tight seal between the body and bonnet.
- 4) Shall be a normally closed, forward flow design.
- 5) Shall have a filtered pilot flow to resist debris and clogging.
- 6) Shall be slow closing to prevent water hammer from causing subsequent system damage.
- 7) Shall have a Ø1 inch NPT globe and angle inlet as well as a Ø1 inch NPT outlet.
- 8) Shall have a manual internal bleed capability to operate the valve without allowing water into the valve box.
- 9) Shall have a non-rising flow control handle to adjust water flow as needed.
- 10) Shall include a 24 VAC 50/60 Hz solenoid capable of 2-wire operation.
  - a) Inrush current: 0.41A (9.9VA) at 60Hz
  - b) Holding current: 0.14A (3.43 VA) at 60Hz
- 11) Operating flow rate of 2-40 gpm (7.6-151.4 l/min).
- 12) Operating pressure range of 15-150 psi (1.04-10.4 bar).
- 13) Water temperature: Up to 110°F (43°C).
- 14) Ambient temperature: Up to 125°F (52°C).
- 15) Shall accommodate an optional field-installed pressure regulating dial.
- 16) Shall accept an optional latching solenoid for use with battery operated controllers.
- 17) Shall be available with an optional purple flow control handle for use with non-potable water applications.
- 18) Shall have a heavy-duty stainless steel spring for positive diaphragm closure.

## 2.6 SPRINKLERS

1. Rotors
  - a. designed to provide uniform coverage over entire area of spray shown on drawings at available water pressure or as follows:
    - 1) Rotor for shrub or small turf areas (25-50 feet) spacing: maximum 65 psi.
2. Pop-Up Spray
  - a. Rotor for shrub or small turf areas (25-50 feet) spacing: maximum 65 psi. Irrigation rotor specifications include but are not limited to:
    - 1) The rotor body, stem and nozzle, shall be constructed of heavy-duty and ultra-violet resistant plastic.
      - a) Shall have a heavy-duty stainless steel retract spring for positive pop-down.
    - 2) Shall have integrated seals and method for clearing debris.
      - a) Oversized pressure activated wiper seal prevents leaks and protects internals from debris.
      - b) Precision controlled flush at pop-down to clear debris from the unit, to assure positive stem retraction in all soil types.
      - c) Ported arc adjustment screw to clear debris from unit at pop-down
    - 3) Shall have a slip clutch installation feature to allow easy arc alignment.
    - 4) Non-reversing 360° full arc rotation.
    - 5) 7.38 inch body height; 4.0 inch pop-up height (measured to center of nozzle).
    - 6) Operating range of 25 to 50 feet.
    - 7) Operating pressure range of 15 to 55 psi.

- 8) Shall have a precipitation rate of 0.20 to 1.50 in/hr.
  - 9) Shall include a green cover and a flow shut-off valve in the rotor head.
  - 10) Exposed surface diameter shall measure 1.5 inch.
  - 11) Shall include Ø3/4 inch NPT female threaded bottom inlet.
  - 12) Shall include a nozzle tree containing twelve nozzles with indicated flow rates from 0.76 to 9.63 gpm and an exit trajectory of 10-25°.
  - 13) All rotor body components shall be removable from the top without special tools in order to provide quick and easy flushing and maintenance of the sprinkler.
  - 14) Shall include slot in cover for use of a pull up tool for ease of nozzle installation and replacement.
  - 15) Shall include nozzle retention screw that may also be used to reduce spray radius by 25%.
  - 16) Shall have a filter screen in the stem to protect the drive from clogging and to simplify removal for cleaning and flushing the system.
  - 17) Shall utilize nozzles designed to deliver even distribution over the entire radius including large wind resistant droplets and gentle close-in-watering.
3. Pressure Compensating Bubbler
- a. Pressure compensating bubblers shall have a full circle discharge rate of 1 GPM at 30 PSI. The bubbler shall be constructed of corrosion and UV-resistant plastic, with an integral elastomeric flow bushing for maintaining a constant flow rate over the operating pressure range of 15 to 7 PSI.
  - b. The bubbler shall be compatible with a plastic filter screen to protect the nozzle from debris in the water. The PCB version shall have a ½-inch Female National Pipe Thread (FNPT) inlet for connection to a ½-inch male threaded riser. The PCN version shall have standard female threads that are compatible with the threaded riser on Hunter spray heads as well as some other manufacturer's spray heads.

## 2.7 DRIP IRRIGATION SPECIALTIES

### A. Lateral Pipe and Fittings

1. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with integral belled end suitable for solvent welding.
2. Use Class 200, SDR-21, rated at 200 PSI (13,8 bar), conforming to dimensions and tolerances established by ASTM Standard D2241. Use PVC pipe rated at higher pressures than Class 200 in the cases where small nominal diameters are not manufactured in Class 200.
3. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of type approved by pipe manufacturer.
4. Use PVC Schedule 80 nipples and PVC Schedule 40 or 80 threaded fittings for threaded pipe connections as specified on the drawings and details.
5. Threaded joint sealant: Use non-hardening, nontoxic pipe thread sealant formulated for use on threaded connections and approved by pipe fitting or valve manufacturer.
6. Hunter On-Surface Dripline with pressure-compensating.

- a. Hunter On-Surface Dripline model numbers for POTABLE water systems; a dual-layered, brown colored dripline tubing with emitter flow rates and spacing as shown:
  - 1) MLD0512250, 12" spacing emitter, thick walled, dual-layered and brown in color
  - 2) PLD-LOC fittings compatible with Hunter Professional Landscape Dripline (PLD)

B. Drip Control Zone Kits

1. The valve, filter and pressure regulator assembly will be capable of operating between 20-120 PSI with a flow range of between 2 - 20 GPM.
2. The valve shall be a normally closed, electronically-actuated, hydraulic, remote-control valve. The valve shall be equipped with a non-rising stem-type, manual flow control mechanism. This mechanism will be operable by hand that will regulate flow from full on to completely off. When specified for use with reclaimed water, a reclaimed water identifier handle shall be available.
3. The standard solenoid shall be a 24 VAC unit with a 350 mA inrush current and 190 mA holding current at 60 cycles and a 370 mA inrush current and 210 mA holding current at 50 cycles. When specified, the unit shall be equipped with a DC latching solenoid for use with 12-volt battery-operated controllers. The solenoid shall be an encapsulated, one-piece unit with captive plunger. It shall be equipped with manual internal bleed capability to release the upper chamber water to the downstream piping, allowing the valve to open. The valve shall have an external manual bleed screw that provides an additional method for manual operation of the valve.
4. The body and bonnet shall be molded of non-corrodible, glass-reinforced nylon, rated to 220 PSI. The body of the valve shall have brass inserts, with through-holes, which will accept the bonnet bolts. The bonnet bolts shall be serviceable with a slotted screwdriver, Phillips screwdriver, or a hex wrench, and shall be held captive in the bonnet when the bonnet is removed from the valve body. The diaphragm assembly shall be of molded construction, reinforced with nylon fabric and have a thermoplastic elastomer seating material. The valve shall be equipped with an internal filter as well as a self-cleaning metering rod, so only clean water can enter the solenoid chamber. In addition, the valve shall be equipped with a filter cleaning system that cleans a stainless steel filter each time the valve opens and closes. All metal parts internal to the valve shall be manufactured from corrosion-resistant stainless steel. A perforated diaphragm support ring shall fit into the valve body just below the diaphragm to relieve stress on the diaphragm when the valve is closed.
5. The valve shall have a 1-inch Female National Pipe Thread (FNPT) inlet and outlet. All valve parts shall be serviceable after installation by unscrewing the bonnet bolts, and removing the bonnet from the valve body to access the internal components. This may be accomplished without removing the valve body from the line.
6. The filter shall be an in-line configuration. The filter will have a 1-inch Male National Pipe Thread (MNPT) inlet and outlet. The housing shall be molded of non-corrodible PVC, rated to 150 PSI. The filter shall be equipped with a 150 mesh stainless steel filter, so only clean water can be discharged through the regulator. The filter assembly must have removable cap for easy service and cleaning.
7. The regulator shall be an in-line configuration. The regulator will have a 1-inch Female National Pipe Thread (FNPT) inlet and outlet. The regulator shall be molded of non-corrodible PVC, rated to 150 PSI. The regulator shall be a non-adjustable pressure-regulating device that is factory calibrated for the correct outlet pressure. The regulator shall be capable of reducing the outlet pressure to 25 or 40 PSI depending on the specified model

when the inlet pressure is 15 PSI or greater than the regulated outlet pressure. The regulated downstream pressure shall remain constant regardless of variations in upstream pressure.

8. The valve, filter and regulator assembly shall be rated for use up to 120 degrees F (49 degrees C).

## 2.8 CONTROLLERS

### A. Description:

1. The controller shall be a full-featured, commercial-industrial product for the purpose of irrigation operation, management, and monitoring of control valves and sensors. The controller shall be of a modular design that is provided with a standard 8-station output module. The controller shall be expandable with 4-, 8-, or 22-station conventional modules or one 54-station decoder output module controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.
2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and two matching keys; include provision for grounding.
  - a. Body Material: Molded plastic.
  - b. Mounting: Pole mounted.
3. Control Transformer: 24-V secondary, with primary fuse.
4. Depending on requirements, transformer input shall be 120 VAC, 60 Hz or 230 VAC, 50 Hz. Maximum output per station shall be 24 VAC, up to 0.56 A. Maximum output per P/MV terminal shall be 24 VAC, up to 0.56 A.
5. The controller transformer shall be equipped with an internal, self-resetting thermal circuit breaker to protect against overheating.
6. The controller transformer shall also be equipped with a ground lug for connecting to proper earth-ground hardware.
7. Station Modules
  - a. Controller shall provide 4 (plastic enclosure) or 6 (metal and pedestal enclosures) separate station output module slots Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.
  - b. Controller shall use 4-, 8-, or 22-station conventional output modules, or one 54-station decoder output module.
  - c. Station modules shall be secured against field wiring tension by locking levers.
  - d. Using conventional wire only, the controller shall be expandable from 8 to 38 stations (plastic) and 8 to 54 stations (metal and pedestals).
  - e. Using conventional station modules in conjunction with one decoder output module (model: EZ-DM), all controller configurations (plastic, metal, pedestal) shall expand up to 54 stations.
  - f. Using only one decoder output module (model: EZ-DM) all controller configurations (plastic, metal, pedestal) shall expand up to 54 stations.
  - g. The controller shall have a base model capacity of 8 stations, consisting of one 8-station output module.



- h. Each station output shall supply 24 VAC, up to 0.56 A current for solenoid activation.
- i. The controller shall have self-diagnostic, electronic short circuit protection that detects a faulty circuit, continues watering the remainder of the program, and reports the faulty station via alert/notification to the user's smartphone, tablet, or computer. The built-in milliamp sensor shall constantly be measuring the current draw of each individual station.
- j. Module hardware
  - 1. The controller output modules shall have metal oxide varistors (MOVs) and copper induction coils on each station output circuit to help protect the micro-circuitry from power surges
    - i. Sensor inputs - The controller shall be equipped with two dedicated general-purpose sensor ports.
  - 2. The sensor inputs shall be compatible with any standard normally closed or normally open "Clik-type" sensors for automatic shutdown during rain, freeze, soil moisture, and/or wind events.
  - 3. The sensor inputs shall also be compatible with the Hunter HC Flow Meter for flow monitoring, alerts, and reporting.
- k. P/MV outputs
  - 1. The controller shall have one built-in P/MV (24 VAC) output with a capacity of up to 0.56 A.
  - 2. The P/MV output shall be selectable as active or disabled per each individual station.
  - 3. A common wire terminal is provided on the controller's power module, and additional commons are provided on each station output module.
    - a. SmartPort®
      - 1) The controller shall be pre-wired with a SmartPort connector for easy connection of optional wireless remote controls.
      - 2) For international or short-range uses, the wireless remote control shall be the Hunter model ROAM with a useful range of up to 1,000' (330 m).
      - 3) For use in the United States or long-range uses, where permitted, the wireless remote shall be Hunter model ROAM-XL with a useful range of up to 2 mi. (3.2 km).
  - 4. 3.10 Wi-Fi information
    - a. The controller shall be equipped with built-in Wi-Fi.
    - b. Wi-Fi operation shall be 802.11 b/g/n.
    - c. Wi-Fi frequency is 2.4 GHz.
    - d. Security shall have the ability to auto detect and offer the following security settings: WPA2, WPA Personal, and WPA Auto.
- 8. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.
- 9. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
  - a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
  - b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.

- c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

## 2.9 BOXES FOR AUTOMATIC CONTROL VALVES

### A. Plastic Boxes:

1. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
  - a. Size: As required for valves and service.
  - b. Shape: Round (for gate valves) and Rectangular for control valves.
  - c. Sidewall Material: PE.
  - d. Cover Material: PE

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."
- B. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.
- C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches to 12 inches below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.
- D. Provide minimum cover over top of underground piping according to the following:
  1. Irrigation Main Piping: Minimum depth of 36 inches below finished grade, or not less than 18 inches below average local frost depth, whichever is deeper.
  2. Circuit Piping: 12 inches.
  3. Drain Piping: 12 inches.
  4. Sleeves: 24 inches.

### 3.2 PREPARATION

- A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

### 3.3 PIPING INSTALLATION

- A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
- B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.
- C. Install piping free of sags and bends.

- D. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- E. Install fittings for changes in direction and branch connections.
- F. Install unions adjacent to valves and to final connections to other components with NPS 2 or smaller pipe connection.
- G. Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690.
- H. Install expansion loops in control-valve boxes for plastic piping.
- I. Lay piping on solid subbase, uniformly sloped without humps or depressions.
- J. Install ductile-iron piping according to AWWA C600.
- K. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.
- L. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.
- M. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.
- N. Install piping in sleeves under parking lots, roadways, and sidewalks.
- O. Install sleeves made of Schedule 40 PVC pipe and socket fittings, and solvent-cemented joints.
- P. Install transition fittings for plastic-to-metal pipe connections according to the following:
  - 1. Underground Piping:
    - a. NPS 1-1/2 and Smaller: Plastic-to-metal transition fittings.
    - b. NPS 2 and Larger: AWWA transition couplings.
  - 2. Aboveground Piping:
    - a. NPS 2 and Smaller: Plastic-to-metal transition fittings.
    - b. NPS 2 and Larger: Use dielectric flange kits with one plastic flange.
- Q. Install dielectric fittings for dissimilar-metal pipe connections according to the following:
  - 1. Underground Piping:
    - a. NPS 2 and Smaller: Dielectric coupling or dielectric nipple.
    - b. NPS 2-1/2 and Larger: Prohibited except in control-valve box.
  - 2. Aboveground Piping:
    - a. NPS 2 and Smaller: Dielectric union.
    - b. NPS 2-1/2 to NPS 4: Dielectric flange.
    - c. NPS 5 and Larger: Dielectric flange kit.
  - 3. Piping in Control-Valve Boxes:
    - a. NPS 2 and Smaller: Dielectric union.
    - b. NPS 2-1/2 to NPS 4: Dielectric flange.
    - c. NPS 5 and Larger: Dielectric flange kit.

### 3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Flanged Joints: Select rubber gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- E. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.
- F. Copper-Tubing Brazed Joints: Construct joints according to CDA's "Copper Tube Handbook," using copper-phosphorus brazing filler metal.
- G. Copper-Tubing Soldered Joints: Apply ASTM B 813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
- H. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.
- I. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1. Plain-End PE Pipe and Fittings: Use butt fusion.
  - 2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
- J. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

### 3.5 VALVE INSTALLATION

- A. Pressure-Reducing Valves: Install in boxes for automatic control valves or aboveground between shutoff valves.

### 3.6 SPRINKLER INSTALLATION

- A. Install sprinklers at manufacturer's recommended heights.
- B. Locate part-circle sprinklers to maintain a minimum distance of 6 inches from walls and 2 inches from other boundaries unless otherwise indicated.

### 3.7 DRIP IRRIGATION SPECIALTY INSTALLATION

- A. Install drip tubes with direct-attached emitters on ground.

### 3.8 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

- A. Equipment Mounting: Install exterior freestanding controllers on pressure treated post.
  - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Install control cable in same trench as irrigation piping and at least 2 inches below piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

### 3.9 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221113 "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.
- C. Connect wiring between controllers and automatic control valves.

### 3.10 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
  - 1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 312000 "Earth Moving" for warning tapes.

### 3.11 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Any irrigation product will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.12 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written Verify that controllers are installed and connected according to the Contract Documents.
  - 2. Verify that electrical wiring installation complies with manufacturer's submittal.

### 3.13 ADJUSTING

- A. Adjust settings of controllers.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
- C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with finish grade.

### 3.14 CLEANING

- A. Flush dirt and debris from piping before installing sprinklers and other devices.

### 3.15 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

### 3.16 PIPING SCHEDULE

- A. Install components having pressure rating equal to or greater than system operating pressure.
- B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.
- C. Underground irrigation main piping NPS 4 shall be one of the following:

1. Class 200 PVC pipe and socket fittings, and solvent-cemented joints.
- D. Underground irrigation main piping, NPS 5 and larger, shall be the following:
  1. Class 200 PVC pipe and socket fittings; and solvent-cemented joints.
- E. Circuit piping, NPS 2 the following:
  1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
- F. Circuit piping, NPS 2-1/2 to NPS 4 shall be the following:
  1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
- G. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.
  1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

END OF SECTION 328400

## SECTION 329200 TURF AND GRASSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sodding.
- B. Related Requirements:
  - 1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
  - 2. Section 334600 "Subdrainage" for below-grade drainage of landscaped areas.

#### 1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See "Soil Preparation (Performance Specification)" and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and



percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

#### 1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

#### 1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

## PART 2 - PRODUCTS

### 2.1 TURFGRASS SOD

- A. Turfgrass Species: Centipede Sod (*Eremochloa ophuroides*).
- B. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

### 2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

### 2.3 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint

- thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

### 3.2 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Coordinate "Placing Planting Soil" Paragraph below with Section 329113 "Soil Preparation" or Section 329115 "Soil Preparation (Performance Specification)."
- C. Placing Planting Soil: Blend planting soil in place.
- 1. Reduce elevation of planting soil to allow for soil thickness of sod.
- D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- E. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- F. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

### 3.3 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
- 1. Lay sod across slopes exceeding 1:3.
  - 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

### 3.4 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering:
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Mow centipede sod to a height of 2 to 3 inch.

### 3.5 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
  - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
  - 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

### 3.6 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove non-degradable erosion-control measures after grass establishment period.

3.8 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Sodded Turf: 30 days from date of Substantial Completion.

END OF SECTION 329200

## SECTION 329300 PLANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

##### A. Section Includes:

1. Plants.
2. Tree stabilization.
3. Erosion-control material(s).

##### B. Related Requirements:

1. Section 329200 "Turf and Grasses" for turf.

##### C. Backfill: The earth used to replace or the act of replacing earth in an excavation.

##### D. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

##### E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

##### F. Finish Grade: Elevation of finished surface of planting soil.

##### G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

##### H. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

##### I. Planting Area: Areas to be planted.

##### J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

- K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- N. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

### 1.3 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
  - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis of standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
  - 1. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
  - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 3. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
  - 1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
  - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
  - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
  - 1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.



- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  - 1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
  - 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  - 3. Do not remove container-grown stock from containers before time of planting.
  - 4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

#### 1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

#### 1.10 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    - b. Structural failures including plantings falling or blowing over.
  - 2. Warranty Periods: From date of acceptance from County.
    - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
    - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
    - c. Annuals: Three months.
  - 3. Include the following remedial actions as a minimum:

- a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
- b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
- c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
- d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

### 2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
  1. See plan specifications.

### 2.3 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  1. See plan specifications.

## 2.4 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide Selective: Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide Selective: Effective for controlling weed growth that has already germinated.

## 2.5 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
  - 1. See plan specifications.

## 2.6 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

### 3.3 PLANTING AREA ESTABLISHMENT

- A. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- B. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

### 3.4 EXCAVATION FOR TREES AND SHRUBS

- A. See plan specifications.

### 3.5 TREE, SHRUB, AND VINE PLANTING

- A. See plan specifications.

### 3.6 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- C. Do not apply pruning paint to wounds.

### 3.7 TREE AND PALM STABILIZATION

- A. See plan specifications.

### 3.8 GROUND COVER AND PLANT PLANTING

- A. See plan specifications.

### 3.9 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
  1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
  2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

### 3.10 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### 3.11 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

### 3.12 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
  1. Submit details of proposed pruning and repairs.

2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
  3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
1. Provide new trees of same size as those being replaced for each tree of 6 inches or smaller in caliper size.

### 3.13 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

### 3.14 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

END OF SECTION 329300