DIVISION 23

HEATING, VENTILATING AND AIR CONDITIONING

PART 1. GENERAL

1.1. **General Provisions:** Division 20 is applicable in full hereto. No materials or products that contain asbestos, formaldehyde, polychlorinated biphenyl (PCB), lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, shall be utilized.

Manufacturers not named in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. All prior approvals shall be submitted through the Architect.

1.2. **Qualifications of Mechanical Contractor:** Shall be properly licensed and established as a Heating and Air Conditioning Contractor at location of the work. He shall have had previous experience in the satisfactory installation of at least six (6) systems of this type, size and scope. The Sub-Contractor shall have an adequate service facility to provide complete service and maintenance of the facility within 100 miles of the installation.

1.3. **General Scope:** Include all equipment, material, and labor required for complete and proper installation and operation of HVAC systems, even though not every item involved is indicated. Do not attach any items to other trades' assemblies. Items shall be attached to building structural system.

Advisory provisions listed in all Codes referenced in the Contract Documents are mandatory. Where conflicts occur between a Code, Standard, the contract drawings or specifications, the most stringent requirements shall govern and be applied.

Manufacturers not named in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. All prior approvals shall be submitted through the Architect. Where substitutions are proposed, unless the Contractor states in writing, on a separate recap/summary sheet in the front of the respective submittal, the differences of the substituted equipment or material, he shall be responsible to replace such items any time discrepancies are found.

Architect shall select all colors where a choice exists.

1.4. **Site Visits:** It is the contractor's responsibility to have the job ready for site visits when they are scheduled. If the project is not ready for the requested site visit and the Architect, any governmental agency or any other entity requires an additional site visit with the Engineer present, the contractor shall pay Zgouvas, Eiring & Associates a re-visit fee of $2,000. The payment shall be made directly to Zgouvas, Eiring & Associates 5 days prior to the scheduled site visit.

The Contractor is urged to carefully review the extensive requirements of Paragraph “Identification” and “Refrigerant Piping Identification” in Division 20 of the specifications. Note that certain identification is required to be completed before certain site visits. There are specific identification requirements prior to the above ceiling and final site visits, respectively, that are mandatory. Failure to comply with this provision will be cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the respective Contractor responsible.

1.5. **Miscellaneous:** Bidders shall visit the site and become acquainted with all job conditions that may affect the work shown on the plans. Report to the Architect, prior to bid, any new or existing conditions that require modifications to accomplish the installation of all items. Provide for required adjustments to complete the intent of the work. No consideration will be given after bid opening for alleged misunderstanding regarding new or existing job conditions, utility connections, permits, fees, etc.

The Contractor shall carefully examine the contract documents during the bidding phase. Any missing information in the contract documents that is required for obtaining accurate pricing shall be brought to the attention of the Architect, **prior to bid date**, so all may be clarified and/or corrected. Failure to identify and resolve the issues prior to bid shall require the Contractor to provide said items, complete, without additional cost to the Owner or the Owner’s Project Design Professionals, using materials and methods specified by, and as directed by, the Owner’s Design Professionals.

1.6. **Identification: Custom factory fabricated refrigerant piping labels are required. Stick-on, painted, stenciled or hand written type identification is not allowed.** The Contractor is urged to carefully review the extensive requirements of Paragraph “Identification” in Division 20 of the specifications and note that certain identification is required to be completed before certain site visits**.** There are specific identification requirements prior to the above ceiling and final site visits, respectively, that are mandatory. Failure to comply with this provision shall be cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the respective Contractor responsible.

1.7. **Painting and Colors:** Furnish to the Architect, color cards for standard and premium colors available. **The Architect shall select color where choices exist**. Refer to Architectural Painting Section of the specifications for additional requirements.

1.8. **Safety Provisions:** Provide covers or guards on all hot, moving and projecting items that may be deemed by the Engineer, Architect or Owner to be a hazard to occupants of the building or to service personnel.

1.9. **Spare Parts:** Manufacturer of any equipment specified shall have a wholesale outlet for readily available replacement parts in the nearest major USA city.

1.10. **Submittals:** Refer to Division 20 for **strict requirements** and, especially as it

applies to format, project cost constraints, addendums and Value Engineering (VE) items.

Only ONE complete submittal will be accepted. Providing submittals piecemeal is not allowed. If a partial or incomplete submittal is provided, it shall be cause for immediate rejection.

1.11. **Firestopping:** Refer to Division 20, Part "Miscellaneous Requirements", Paragraph "Firestopping". In general, a U.L. listed firestopping assembly shall be required and provided. **Note that Division 15 firestopping specifications require firestopping of all penetrations regardless of wall/ceiling/floor construction.** Refer to Division 1 for additional requirements. Where there is a conflict between Division 1 specifications and Division 15 specifications, the most stringent requirements shall govern, be applicable and shall be provided.

1.12. **Service, Charges, Lubrication, Filters, etc.**: Furnish complete first charges of refrigerant, lubrication, oils, etc., and be responsible for such full charges for the guarantee period. Provide service and maintenance for all equipment and systems during the guarantee period. As a minimum, quarterly service calls and reports are required. Make last service call two weeks prior to year-end site visit. All quarterly service shall include lubrication of all motors, bearings, calibration and adjustment of all controls and equipment, full refrigerant charge, new filters, belts, etc.

The Contractor is responsible for quarterly filter changes of all disposable filters, and cleaning of all washable filters, during the guarantee period. The Contractor shall inscribe onto the disposable filters' casing the date filters were installed/replaced.

The Contractor shall furnish to the Architect and the Owner individual written service reports for all work done under this warranty. Failure to provide the Architect with the Owner's written acknowledgement of service calls shall be construed to mean that the service calls have not been accomplished and are still required.

1.13. **Field Instructions:** The Contractor shall operate all systems for a period of six (6) days after completion of the work. During this time, provide competent personnel to thoroughly instruct representatives of the Owner in the proper operation and care of all equipment and control systems. Secure written acknowledgement of such training from the Owner. Failure to provide the Architect with the Owner's written acknowledgement of this training shall be construed to mean that the instructions have not been accomplished and are still required.

1.14. **Operating and Maintenance Manuals: Two weeks before the final site visit**, furnish three complete sets of operating and maintenance instructions, bound in hard cover, indexed and tabbed.

The Contractor shall also provide this information in digital Adobe Acrobat PDF format, on a CD-R CD. The PDF file shall be provided with an

embedded index for each item specified. The index shall appear in the left hand window of the opened document so that the Owner or his maintenance personnel can “click” on the indexed item and move immediately to that specific item.

Minimum requirements for the Operating and Maintenance Manuals shall be as follows:

a. The first page of the bound instructions shall be a listing of:

    1. The Owner/Project Title.
    2. The Architect and Architect’s Job Number.
    3. The Engineer and Engineer’s Job Number (Found in the Engineer’s Logo in the Bottom Right Corner of the Mechanical Plans).
    4. The General Contractor and Contact Information.
    5. The Mechanical Subcontractor and Contact Information.
    6. HVAC Controls Subcontractor and Contact Information.

b. Second page shall be a Table of Contents listing all products in the order which they appear in the specifications and label the tab accordingly. Include all equipment using nomenclature shown on the Mechanical plans, UV-C lights, and similar devices, control valves, motorized dampers, fire dampers, etc.
c. The third page shall be a summary page that lists each item with its respective warranty, including all extended warranties.
d. All warranty card information shall be filled in by the Mechanical Contractor; Serial numbers, Model Numbers, etc. all as required for proper warranty registration. Warranty registration date shall be the date of substantial completion as determined by the Architect.
e. Provide copies of all filled in warranty cards.
f. Provide a local source of supply for parts and replacement, including names and telephone numbers of parts suppliers.
g. Provide a general maintenance summary section. Section shall be a list of each piece of equipment or device using the designations as shown on the plans, and the routine maintenance procedures based on the respective manufacturer’s recommended intervals. As a minimum, maintenance shall be grouped and individually tabbed to indicate maintenance operations required:

    1. Once a month
    2. Quarterly
    3. Once every six months
    4. Once a year

h. Provide copy of results of all tests specified.
i. Copy of Test and Balance Report.
j. Copies of all the Mechanical Engineer’s Site Visit Reports including Contractor’s written response that items listed were corrected.
k. Copies of all certificates of all site visits, comments and approvals from all Governing Authorities.

l. Provide copy of all start-up reports specified.
m. Provide copy of Division 20 and Division 23 Specifications.
n. Provide a copy of all shop drawings/submittals.
o. Provide drawings of system control and wiring diagrams, condensed operating instructions, specified sequences of operation. Include hard copy in binder and digital copy on CD in PDF format. All components shall be numbered and identified on diagram. Laminate, frame under plastic and mount in Custodian Room in an optimally viewed location.
p. Provide record drawings of the Mechanical drawings, in hard copy and PDF format on CD. Refer to Division 20, Part 1, General, Paragraph, Record Drawings for detailed requirements.

1.15. **Warranty:** Guarantee work as set forth in Division 20 and Division 1. Guarantee in writing to make good without cost any defects in materials and workmanship for one year following the date of substantial completion of the project, as determined by the Architect. Provide free maintenance and service during the guarantee period to **include furnishing and replacing of filters, and the cleaning of all washable filters.** Refer to other parts for additional requirements and extended warranty requirements.

PART 2. ELECTRICAL WORK AND EQUIPMENT

2.1. **Power:** All power wiring required for installation of equipment is specified under Electrical Division. Electrical equipment shall be compatible with the current shown on electrical drawings. **Contractor shall verify all voltage and power requirements with Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.**

2.2. **Motors:** All motors furnished shall be designed, manufactured, and tested in accordance with the current applicable standards of NEMA, ANSI, IEEE, and ASTM. As a minimum requirement, all motors shall conform to the current applicable sections of NEMA Standard No. MG-1, Part 3. Motors must meet or exceed The Consortium for Energy Efficiency (CEE) Premium Efficiency™ full load efficiencies. All motors 1 HP and over shall be premium efficiency. All motors with scheduled capacity of less than 1 HP shall be ECM type as required by ASHRAE 90.1 and with minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431.

All motors shall be listed under UL recognized component file as applicable. All motors shall be suitable for installation according to the requirements of NEC. Motors shall be wound for the specified voltage and a 1.5 service factor, 1750 RPM open drip proof construction and minimum of Class “F” insulation unless otherwise shown or specified.

The bearings shall have a rated fatigue life of B-10 of 150,000 hours for direct-coupled applications and 50,000 hours for belted applications minimum. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG 1. Load on motors shall not exceed 100% nominal horsepower. Routine factory testing shall be conducted in accordance with Method B of IEEE 112 (current edition), Standard Test Procedure for

Polyphase Induction Motors and Generators and shall be as described in Article 12.55 of NEMA MG1, Motors and Generators. **Premium efficient motors shall be warranted for 36 months from date of substantial completion of the project as determined by the Architect.**

Where shown, specified or required, furnish increment wound motors for two-step starting. All motors shall be provided with overload protection and phase protection on all legs. Do not run motors until correct overload elements are installed in starters. Trading overload elements for elements of correct size for motors actually furnished shall be included in this Section.

All motors serving outdoor equipment exposed to weather shall have TEFC motors meeting the requirements set forth previously.

Motors shall be by Allis Chalmers, General Electric Goulds, Louis Allis, Westinghouse or approved equivalent.

2.3. **Fusing:** Provide factory installed fuses in all equipment requiring fusing for branch circuit protection.

2.4. **Motor Starters as Required:** To be furnished under this Section; installation thereof is specified under Electrical Division, except for those which are specified to be factory assembled. Starters shall be Cutler-Hammer, Allen-Bradley, Square D or General Electric. Starters shall be U.L. and NEMA approved. Where required for interlocks provide built-in step down transformer. Motors for VFD drives shall be designed for NEMA MG-1, Part 30.

Motor starters shall be mounted on wall at accessible height standing from floor. Equipment mounted or Uni-strut type frame mounting is not acceptable.

Provide for each motor or group of motors requiring a single control (and not controlled from a motor-control center), a suitable controller and devices that shall function as specified for the respective motors.

Provide overload protection for each ungrounded conductor to each motor 1/8 HP or larger (manual reset type unless indicated otherwise). The overload-protection device shall be integral with the motor or controller. Unless indicated otherwise, furnish pilot lights with all remote starters. Where auxiliary control devices are connected into control circuit, these devices shall not bypass safety controls (motor-overload protective devices, high-pressure cutouts, low pressure cutouts, etc.). Provide "Hand - Off - Auto" switches, auxiliary contacts, etc. for all starters.

2.5. **Unit Protection:** All fan motors, indoor units, outdoor units, condensing units, packaged units, etc., shall be provided with equipment manufacturer, factory installed surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. When not available from the equipment manufacturer, protection shall be provided for all 3-phase equipment utilizing ICM Controls Model 450 A Plus+ or equivalent. All single phase equipment

with horsepower greater than or equal to 1/8 HP shall be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. The Contractor shall consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities. Phase protection is not required on equipment being controlled via a variable speed frequency drive; if the specified protection is inherent with the variable speed drive furnished.

2.6. **Controls:** All HVAC controls cabling and wiring shall be in EMT conduit (no "whips") or on J-hooks. Above accessible lay-in ceilings, control wiring shall be installed on J-Hook assemblies. Above all hard, inaccessible ceilings, in all mechanical rooms and in areas with exposed structure (no ceilings), controls wiring shall be in conduit. Do not attach any wiring, cabling or conduits to refrigerant piping.

Do not route control wiring through sleeves containing piping. **All control wiring penetrating any exterior wall, interior partition, floor, and similar construction shall be in EMT conduit. Through the base control wiring/conduit is not allowed.** EMT control conduit shall be as specified in the Electrical Division of the specifications and/or as shown on electrical drawings. Minimum HVAC Controls conduit size shall be 3/4" in size. All control conduit, power, relays, contactors, transformers, wiring, etc., required for a complete functional system as specified, shown on the plans, or as required to accomplish the specified sequences of operation, which is not shown or specified by the Electrical Division, shall be furnished and installed by the HVAC Controls Contractor. This shall include all power, interlock control wiring between the various components of the heating, ventilating and air conditioning system and lighting interlocks.

Electrical work performed under this Section shall conform to requirements set forth in the Electrical Division of the specifications. All wiring shall be in accordance with the National Electrical Code, and all State and local codes. Coordinate all requirements with the Electrical Sub-Contractor prior to bid and provide all as required.

All thermostat and humidistat boxes shall be mounted 46" A.F.F. to the center of the box (ADA height). Where wall mounted CO_2 Sensors are indicated, they shall be mounted 58" A.F.F to the center of the box. Electrical work performed under this Section shall conform to requirements set forth in the Electrical Division of the specifications. All wall-mounted devices shall be provided with hinged, locking metal covers with rounded edges.

All work shall be done by an approved, independent HVAC Controls Contractor whose primary business is the installation and servicing of HVAC controls systems.

2.7. **Controls and Instrumentation Cable:** Instrumentation cable shall be minimum AWG as recommended by the equipment Manufacturer or the HVAC controls system Manufacturer. The most stringent shall be provided. All wiring, cabling, conduit, connections, etc., shall be plenum rated and rated

for use at temperatures and conditions expected in the location of mounting. Do not attach any wiring, cabling or conduits to refrigerant piping.

2.8. **Wiring Diagrams:** Furnish to the Electrical Contractor for the specific makes and models of electric-motor operated equipment to be installed. **Contractor shall verify all voltage and power requirements with Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.**

2.9. **Modifications:** The cost of any modifications of the electrical power wiring, breakers, and/or control wiring conduit, etc. that is required for any items specified in this Division 23, or controls having electrical power requirements differing from that shown on the electrical drawings and/or as specified, shall be the responsibility of the Mechanical Contractor.

PART 3. VIBRATION AND NOISE CONTROL

3.1. **General:** Elimination of objectionable vibration and noise is the responsibility of the Contractor, who must provide all foundations, isolators, flexible connections, air chambers, curbs, etc. required thereby. Pay special attention to vibration problems at year end site visit and correct all deficiencies noted.

All items of mechanical equipment and fans shall be properly isolated from the structure by means of the Engineer's approved vibration absorbing accessories, foundations or supports.

3.2. **Packaged Rooftop Heat Pump Units:** Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal or structural steel sections containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive to resiliently resist wind forces and withstand the minimum wind loads prescribed in Florida Codes. All directional neoprene snubber bushings shall be a minimum of 1/4" thick. Steel springs shall be laterally stable and rest on 1/4" thick neoprene acoustical pads. Hardware must be plated, and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous flexible flashing nailed over the lower curbs waterproofing. All spring locations shall have accessibility to adjust springs. Lower curbs shall have provision for 2" of insulation and shall be insulated as recommended by the supports Manufacturer. The roof curbs shall be built to seismically contain the rooftop unit. The unit shall be solidly fastened to the top floating rail, and the lower section anchored to the roof structure. Curb shall be type SRSC or RMSS as manufactured by Mason Industries, Inc. The floating member of the roof curb shall have perimeter angle and cross members to support two layers of 5/8" waterproof sheetrock laid on with staggered joints. Sheetrock shall surround ducts to provide a continuous sound break. This acoustical barrier shall be caulked to minimize sound transmission. Where the mechanical arrangement makes attachment to the floating member unfeasible, the barrier shall be attached at the highest practical elevation of the fixed curb with provision for 1" thick closed cell

neoprene flexible seals around the ductwork. A single four-inch layer of 1.5 density fiberglass shall cover the entire solid roof surface under the unit. Ductwork shall be lined with acoustical liner material. Refer to Part "Duct Insulation Work (Internal)", for acoustical liner required. Complete instructions shall be provided by the spring isolation curb Manufacturer. This Contractor shall coordinate all requirements for installation of sheetrock, insulation, etc., with the General Contractor and provide all as required for a complete installation as recommended by the curb Manufacturer. All curbs shall be factory painted with color selected by the Architect. **Do not route power or control wiring and conduit through the curb.** Coordinate requirement with the electrical plans and electrical contractor and provide as specified. See plan details for additional requirements. Curbs shall be Mason Industries, Inc. Type RSC-dB or equivalent by Amber-Booth, Vibro-Acoustics or Kinetics Noise Control. **Mason Industries is the basis of design**.

3.3. **Sound Levels:** Sound levels caused by operation of pumps, fans, air handling systems, etc., whether generated within rooms or transmitted to rooms through ducts, walls or floors, pipes, etc., shall not exceed specified NC rating at any point within room not more than 6 feet from an air outlet in accordance with ASHRAE octave band method. Offices, exam rooms, conference rooms and similar spaces shall have maximum NC-30; corridors, and lobbies, NC-35; toilets, NC-40.

PART 4. TESTING, START-UP, BALANCING, ETC.

4.1. **General:** Conduct tests upon completion of the heating, ventilation and air conditioning installations, and at times as designated by the Architect. Furnish written reports to the Architect of all tests results. Provide copies of all test results in the Bound and Framed Instructions specified hereinbefore. Furnish all necessary personnel, test instruments, power, fuel, etc., as required to complete the specified requirements.

4.2. **Refrigerant Piping Testing:** The Mechanical Contractor shall test the refrigerant piping installation. The medium used for pressure testing the refrigerant system shall be oxygen-free nitrogen, helium or argon. Oxygen, air, combustible gases and mixtures containing such gases shall not be used as a test medium. Systems erected on the premises with tubing not exceeding 5/8 inch outside diameter shall be allowed to use the refrigerant identified on the nameplate label or marking as the test medium.

The refrigerant piping system shall be tested as a whole or separate tests shall be conducted for the low-pressure side and high-pressure side of the piping system. The refrigerant piping system shall be tested in accordance with both of the following methods:

Test 1: The system shall be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing shall be the pressure listed on the label nameplate of the condensing unit, compressor,

compressor unit, pressure vessel or other system component with a nameplate. Additional test gas shall not be added to the system after the start of the pressure test. The system shall not show loss of pressure on the test pressure measuring device during the pressure test for a minimum 24 hours.

Test 2: A vacuum of 500 microns shall be achieved. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise above 1,500 microns for a period of not less than 60 minutes.

Where using refrigerant as a test medium as specified above, the test pressure shall be not less than the saturation dew point pressure at 77°F.

4.3. Ductwork for Systems Less Than 2,000 CFM: The Mechanical Contractor shall test all supply, return, relief and outside air, exhaust ducts, plenums and casings and make substantially airtight before covering with external insulation or concealing masonry. Substantially airtight shall be construed to mean that no air leakage is noticeable to the senses of touch or sound at joints.

4.4. Domestic Water Circulating System: The Testing and Balancing Contractor shall test and adjust domestic water recirculation system to ensure hot water circulation in all mains. Provide flow rate of pump and determined head.

4.5. Performance Tests: After cleaning, balancing, and testing are completed as specified, test each system as a whole to see that all items perform as integral parts of the system, and that temperatures and conditions are evenly controlled throughout the building. Verify all sequences of operation and submit report. Make corrections and adjustments as necessary to produce the indicated conditions.

All work shall be performed by an independent test and balancing agency whose primary business is the testing and balancing of heating and air conditioning systems and its related components. The Test and Balancing Contractor shall hold a current NEBB, NBC or AABC certification. Proof of certification shall be provided at the submittal stage.

The test shall cover a period of not less than three days and shall demonstrate that the entire system is functioning properly. Provide the following:

Date of testing, space temperature and humidity, outdoor air temperature (DB & WB), air temperature entering condenser coil; refrigerant suction temperature and pressure at compressor evaporator coil; condensing temperature and pressure and load amperes for all motors. Also, provide CFM readings at all grilles, registers and diffusers and entering and leaving air temperatures at each evaporator coil.

Provide typed list indicating job setting of all automatic controls. Include settings of thermostats, humidity controls, CO_2 sensors, safety controls,

minimum damper settings, fire-safety thermostats, pressure controls, temperature controls, and other similar items. Tabulate to show type of control, location, setting and function. Verify that all safety settings and limits are appropriate and comply with current safety Codes and Regulations for the respective system.

After building is occupied, make adjustments as requested by Owner.

4.6. **Balancing:** The Testing and Balancing Contractor shall check airflow at all supply air, return air and exhaust air devices, all diffusers and outside air intakes with a recently calibrated direct-reading velocity instrument. Adjust systems to deliver, supply air, return air, outside air and exhaust air quantities to within 10 percent of the indicated amounts. Provide instruments and otherwise assist Architect in checking balancing at final site visit.

4.7. **Unit Protection Verification:** The Test and Balance Contractor, with cooperation from the Mechanical Contractor, shall verify that all phase protection specified has been installed where specified, and installed per the Manufacturer's requirements. The verification of this requirement shall be furnished in tabular form with findings included in the test and balance report. The summary shall list all equipment specified to have the protection, verification that the device is installed per the Manufacturer's recommendation and has been programmed to the Owner's requirements.

4.8. **Test Data:** The Testing and Balancing Contractor shall submit typewritten report as specified above. Include schedules of readings taken during the testing and balancing operations and a line diagram or plan of the system indicating specified quantities and final balanced quantities **seven (7) days prior to final site visit**. **No final site visit shall be made without this data.** Report the required or specified reading, the first reading taken, and final balanced reading for the following items:

Fans: Size, type, fan motor speed in rpm, outlet velocity in fpm, static pressure inches water, air quantity in cfm, and motor load in amperes.

Air Handling Equipment: Size, type, fan speed in rpm, outlet velocity in fpm, external static pressure inches water, total static pressure inches water, air quantity cfm, and motor load in amperes.

All Air Outlets and Inlets: Size, velocity in fpm, and air quantity in cfm.

Coils: CFM, size, face velocity in fpm; air temperature entering coil and air temperature leaving coil, wet-bulb and dry-bulb degrees F.

Refrigerant Hot Gas Reheat Coils: The Mechanical Contractor, with assistance from the Testing and Balancing Contractor shall adjust the humidistat so that the hot gas reheat coil valve opens. Verify modulation of the coil valve. Provide coil size, face velocity in fpm; air temperature entering coil and air temperature leaving coil, wet-bulb and dry-bulb degrees F.

Ducts: Size, velocity in fpm, and air quantity in cfm.

Heat Pumps Auxiliary Heaters: Provide heater capacity (KW), number of stages of heat and load amperes.

Air Cooled Condenser Sections of All Outdoor Units: Air temperature entering condenser coil; refrigerant suction temperature and pressure at compressor and evaporator coil; condensing temperature and pressure and load amperes for all motors.

4.9. Control Settings: In cooperation with the Mechanical Contractor, the HVAC Controls Contractor shall calibrate, adjust, and verify sequences of operation and the control systems, including the refrigerant hot gas reheat coils, to show that the requirements of these specifications have been met.

Verify all specified sequences of operation and provide report.

Provide a tabulation of setting on all controls indicating set point and throttling range, etc. after controls and systems have been finally adjusted. Include settings on safety controls and cutouts. Verify that all safety settings and limits are appropriate and comply with current safety Codes and Regulations for the respective system. Provide typed list indicating job setting of all automatic controls. Include settings of thermostats, humidity controls, CO_2 sensors, safety controls, minimum damper settings, fire-safety thermostats, pressure controls, temperature controls, and other similar items. Tabulate to show type of control, location, setting and function. Verify that all safety settings and limits are appropriate and comply with current safety Codes and Regulations for the respective system.

4.10. Seasonal Adjustments: At the beginning of the first heating season adjust and balance operating phases and repeat at the beginning of the first cooling season or vice versa as requested by the Architect or Owner.

4.11. Notification: Notify the Architect one week prior to all testing. The Contractor shall provide all testing equipment and shall furnish written reports to Architect of all tests results. Additionally, provide copies in the Bound and Framed Instructions specified hereinbefore.

PART 5. SHEET METAL DUCT WORK (LOW VELOCITY 2" S.P.)

5.1. General Scope: Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions, offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required. Refer to architectural drawings and specifications.

Ductwork visible through all grilles, registers, diffusers, ceilings, etc. shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

5.2. **Protection of Interior of Duct from Debris:** ALL open portions of ductwork shall be covered with a self-adhesive film or airtight sheet metal caps to prevent the intrusion of contaminates. All duct taps, duct take-offs, etc., shall be protected immediately after the tap, take-off, etc. has been fabricated in the field. When sections of sheet metal are delivered to the facility for fabrication in the field, which cannot be protected with the specified material, the sheet metal shall be covered with Visqueen. Prior to erecting same, ductwork shall be manually cleaned to remove all dust, dirt and construction debris. All ductwork shall be erected clean. After each section of ductwork is erected, immediately protect all openings as specified herein before. In effect, there shall be no ductwork opening that is exposed to the ambient air. The material shall be a minimum of 3-mil thickness and have a minimum tensile strength of 10 psi. It shall be UV resistant, waterproof and recyclable. Material shall be DuroDyne Dyn-O-Wrap or approved equivalent. **Any ductwork discovered to be unprotected as specified is subject to immediate rejection for use on this project.**

5.3. **Protection of Interior of Ductwork and Equipment When Any Air Moving Equipment is Operating During Construction and Prior to Owner's Occupancy:** It is the Mechanical Contractor's responsibility to ensure the inside of each air handling unit and associated air distribution system is kept clean and not allow construction dust to infiltrate the system. Should the system become contaminated as determined by Architect, Engineer or Owner, the Mechanical Contractor shall be responsible for cleaning.

If air moving equipment must be used during construction, temporary filtration media with a Minimum Efficiency Reporting Value (MERV) of 8, as determined by ASHRAE 52.2 and shall be installed at each return air grille, return air register, exhaust grille, exhaust register, and unit return air inlet.

The General Contractor shall provide a written request to the Architect for permission to temporarily operate any HVAC equipment during construction. The request shall be provided a minimum of seven (7) days prior to the desired date of the interruption. Do not operate any equipment without the Architect's written approval.

5.4. **Sizes:** Take measurements at job and fit work into available space. Report to the Architect any unworkable conditions encountered and alter layout or duct sizes as directed without additional cost to the Owner or the Owner's Project Design Professionals. Unless otherwise approved, conform to dimensions indicated. Duct dimensions shown indicate NET FREE AREA after installation of duct liner; increase sizes indicated to allow, therefore.

5.5. **Sheet Metal:** ARMCO, or equal, prime quality, G-90 galvanized sheet steel. Unless indicated otherwise on the plans, gauges shall be as recommended in the current edition of current SMACNA "Duct Construction Standards" but in no case shall be less than listed in the table below for the respective duct largest dimension or diameter.

Up to 30 inches	24 ga.
31 to 54 inches	22 ga.

5.6. **General Fabrication:** Construct and erect in a skillful manner, meeting requirement of the current SMACNA "Duct Construction Standards" for 2" static pressure unless noted or specified otherwise. Where conflicts occur between current SMACNA requirements and the contract drawings or specifications, the most stringent requirements shall apply. In general, the heaviest gauge metal and the strictest installation/fabrication methods shall be provided. Form straight and smooth on the inside, with joints neatly finished. Make up in sections of such length that mechanic can reach thru open end to seal insulation at previous joint. Assemble and anchor to be completely free from vibration and drumming under all conditions of operation. Make takeoffs at round ducts with prefabricated round-to-rectangular and rectangular-to-round transitions.

All rectangular ductwork traverse joints shall be made with all metal DuctMate joints system as manufactured by DuctMate Industries, Inc., Quikduc Transverse Duct Connection Systems, Duro Dyne Dyn-O-Mate or approved equivalent. DuctMate system shall be installed in strict accordance with current SMACNA and Manufacturer's recommendations and instructions.

Where ductwork penetrates non-rated partitions above the ceiling or insulation support/attic air barriers, draft stops and similar partitions, the openings shall be sized as required for duct and insulation, plus 1". Provide duct supports as specified within 12" of each side of the partition penetrated. **DO NOT ALLOW DUCT TO REST ON PARTITION WALLS**.

Openings shall be saw cut or properly blocked out and present a neat appearance.

Where penetration occurs at rated assemblies, provide appropriate fire damper and install as specified and detailed.

Where penetration occurs at non-rated assemblies, fill void between partition and duct with fire resistant mineral wool insulation and seal on both sides of the partition with fire stopping material to prevent the passage of smoke and fire. Thereafter, provide a 4" wide, 16 gauge galvanized steel closure plate around the opening on each side of the partition. Closure plates shall fit snugly to duct and shall be secured to wall. All ductwork and closure plates that are exposed to view in finished areas shall be primed and painted as directed by the Architect. **Do not install closure plates until Engineer or Architect has verified the proper sealing of the penetration.**

Provide additional supports to raise ductwork off any metallic item above the ceiling. Wherever any bare metallic piping, conduits and metallic structural members are in contact with externally insulated duct or bare sheet metal duct, there shall be dielectric separation provided. The Contractor shall provide 3/4" thickness, **unslit** AP Armaflex insulation of sufficient inside tubular diameter to snuggly and completely cover the respective metallic item. The insulation shall extend the full length of the affected area plus 6" on both sides. Refer to Part "Pipe and Miscellaneous Insulation Work" in this division for AP Armaflex material specification. The use of Rubatex insulation between piping and the ductwork shall only be allowed when providing the proper supports is not an option.

Refer to Paragraph "Hangers and Supports" for additional requirements.

5.7. **Ductwork:** Install tight against the wall, overhead structure or ceiling with drive slip joints and other supports as required. Refer to Architectural plans for duct locations. If duct locations are not shown on the Architectural plans, coordinate locations with the Architect prior to fabricating or installing any ductwork.

Required openings in interior walls and partitions shall be saw cut or properly blocked out and present a neat appearance. Where penetration occurs at rated assemblies, provide appropriate fire damper and install as specified and detailed. Where penetration occurs at non-rated assemblies, fill void between wall and ceiling assembly and duct with fire retardant mineral wool insulation and seal both sides of the partition or ceiling with fire stopping material to prevent the passage of smoke and fire. Thereafter, provide a 4" wide, 16 gauge galvanized steel closure plate around the opening. Closure plates shall fit snugly to duct and shall be secured to wall/ceiling/partition.

All ductwork and closure plates that are exposed to view in finished areas shall be primed and painted as directed by the Architect. **Do not install closure plates until Engineer or Architect has verified the proper sealing of the penetration.**

All ductwork traverse joints shall be made with all metal DuctMate joints system as manufactured by DuctMate Industries, Inc., Quikduc Transverse Duct Connection Systems, Duro Dyne Dyn-O-Mate or approved equivalent. DuctMate system shall be installed in strict accordance with current SMACNA and Manufacturer's recommendations and instructions.

5.8. **Cross-Joints, Seams and Stiffening:** Join and stiffen with combination of joint types and structural angles as recommended in current SMACNA "Duct Construction Standards". **Cross break all flat areas over 35 inches wide.** Install internal ends of slip joints in the direction of flow.

All transverse joints with long dimension over 24" shall be made with all metal DuctMate joints system as manufactured by DuctMate Industries, Inc., Quikduc Transverse Duct Connection Systems or Dyn-O-Mate with roll-formed flanges, corner pieces, gasket, and cleat. System used shall be installed in strict accordance with current SMACNA and Manufacturer's

recommendations and instructions.

Make all cross joints and all branch, grille and diffuser take-offs, except DuctMate joints, air tight by applying fibrated, low VOC, LEED IEQ 4.1 compliant duct sealer. Sealer shall meet and pass ASTM D-2202, ASTM C-731 and EPA regulations. Sealer shall meet the requirements for the pressure classification of the ductwork installed. Sealer shall be Hardcast Iron Grip 601 with 10-year warranty or equivalent by Foster or Childers.

5.9. **Branch Ducts to Diffusers:** Round runouts to diffusers, up to and including 14" round, shall be 24 ga., G-60 galvanized, DuctMate Series GreenSeam +Snap Lock pipe with factory sealed longitudinal and transverse gaskets. Gasket for GreenSeam +Snap Lock pipe shall contain antioxidants, fungicides, adhesion promoters, zero VOCs and shall meet or exceed ASTM E-84 test requirements. 16" round to 20" round runouts shall be 24 ga. and equal to DuctMate Series Reeves Lock Pipe, G-60 galvanized pipe.

5.10. **Branch Duct Take-Off:** Provide at all points where branch ducts take off from trunks, and where ducts divide. Refer to details on the drawings. Damper shall be minimum 22 Ga., G-90 Galvanized steel with 2" build out. Body shall be a minimum of 24 Ga., G-90, galvanized steel with 4" W.G. construction. Fitting shall have 1" flange with corner clips, pre-punched mounting holes and adhesive coated gasket. Take-off shall be Flexmaster LDS, BO3, GSI HETO (high efficiency take-off) HTS2, Elgen HET or preapproved equivalent.

5.11. **Turns and Transitions:** Fabricate turns with an inside radius equal to width of duct. At 90-degree turns, Contractor may substitute square elbows, with standard factory-made, multiple, double-blade constructed vanes. Vanes shall be a double wall, true airfoil contour with smoothly rounded entry nose with extended trailing edge. Vanes shall be formed from a single piece of 26 ga., hot dipped galvanized steel and shall be 3" radiused vanes on 2.4" centers. Vanes shall be provided with two (2) tie rods and continuous internal tubes for stiffening and rigidity. Maximum pressure drop shall be .06" W.G. at 1500 FPM. Generated sound power level shall not exceed 54 decibels in band 4 at 2000 FPM (24"x24" duct size). **Single wall turning vanes are not allowed.** Vanes shall be as manufactured by Aero/Dyne Series HEP, Duro Dyne HTV/DHV, Hamlin Sheetmetal, Spiral Systems Inc or approved equivalent by DuctMate. Avoid abrupt changes in shape, with a slope of 4:1 the minimum allowed.

5.12. **Motorized Dampers Used with Automatic Controls:** See Controls at end of Division 23.

5.13. **Volume Dampers:** For round ducts less than 12" diameter and rectangular ducts less than 12" in height in either dimension: Single leaf, constructed with 18-gauge galvanized metal with locking type control quadrant, single center U-bolt and pivot rod extending through opposite side of duct with brass bushing at both ends.

5.14. **Volume Dampers:** For round ducts greater than or equal to 12” diameter or rectangular ducts greater than or equal to 12” height in either direction, provide opposed blade, airfoil blades of 16 ga.-galvanized steel mounted in steel frames by 3/8” steel trunnions riding in brass bushing with dual U-bolts. Blade width shall not exceed 10 inches and individual blade length shall not exceed 48 inches. Extend one trunnion to permit operation from outside the duct. Provide manually operated dampers with cadmium plated steel locking quadrant. Dampers opening to the outside shall have felted edges.

5.15. **Stand-Off Mounting Brackets:** Locking-type quadrant operators for dampers, when installed on ducts to be externally insulated, shall be provided with standoff mounting brackets, bases or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Standoff mounting items shall be integral with the operator or standard accessory of the damper Manufacturer.

5.16. **Access Panels/Doors:** Provide double wall access door in the side of the duct for each motorized damper and elsewhere indicated, specified or required for proper maintenance. Size and position to provide maximum access to all items. Typical doors shall be double metal faced, 22 ga. steel door panels and 22 ga. frame, internally insulated same as duct (1” minimum) fiberglass insulation, neoprene gasket seal and full length plated steel piano hinges with cam lock. Provide access panels/doors with cam locks only, where hinged access panels/doors cannot be completely opened without obstruction. When access panels/doors are provided with cam locks only, they shall be provided with a safety chain. Access panels/doors shall be rated for the anticipated duct pressure, plus 1”. All access doors located outside shall be airtight and weatherproof.

Hinged access doors shall be Ruskin Series ADH22. Removable access doors/panels with cam locks shall be Ruskin Series ADC22 with minimum of two cam locks and safety chain. Nailor Industries Model 08SCL/Model 08SH, Kees ADH/ADC or Pottorff Series HAD/CAD will be acceptable.

For ducts 10” round and smaller, access doors shall be flush mounted, flat oval, 1” insulated, low leakage, 20 ga. steel door panels and frame, except with two large hand knobs or cam locks with safety chain, and equivalent to Ruskin Model ADR1 for round ducts or equivalent by Nailor, Kees or Pottorff.

Hinged access doors for round ductwork shall be flush mounted, flat oval, 1” insulated, low leakage, 20 ga. steel door panels and frame, except with two large hand knobs or cam locks with safety chain, and equivalent to Ruskin Model ADR2 for round ducts 12” round, up to and including, 16” round duct. Nailor Series 0800, Pottorff Series DMR or equivalent by Kees will be acceptable.

Refer to other sections for access doors required in kitchen hood exhaust ducts, moisture-laden ductwork, etc.

Refer to Division 20 for additional access door/panel requirements including identification.

5.17. **Duct Instrument Test Holes:** Provide for each system four test holes (two in supply duct and two in return air plenum) at opposite ends near air handling units with screwed caps. In addition, at duct mounted coils and electric duct heaters provide one on either side of the coil or duct heater.

5.18. **Flexible Connections and Bonding Jumpers:** Install so that the cloth is in folds (not drawn tight). Connect all ducts to air handling equipment and fans with preassembled flexible connection. Fabric width shall be 6" for all air handling equipment. Ceiling mounted exhaust fans be 4" width.

Connectors for all air handling equipment shall be a factory fabricated and assembled unit with 6" dual fabric, heavy duty, 20 oz/sq. yd polyester/polyester fabric with flame resistant coating and mildew resistant per ASTM G-21. The assembly shall comply with NFPA 701, NFPA 90A, NFPA 90B and ASTM E-84. The unit shall be constructed of minimum 24 ga. galvanized steel meeting ASTM A-653-94-G60. Metal to fabric connectors shall be double locked, airtight and waterproof to 10" W.C. positive pressure and 10" W.C. negative pressure. Assembly shall be DuctMate PROflex with power lock connection or approved equivalent by DuroDyne.

Flexible connections for ceiling exhaust fans shall be preassembled flexible connection of 29 ounce fire-resistant, neoprene coated glass fiber cloth equal to Ventfabrics "Ventglas" (4" fabric width), as manufactured by Ventfabrics, Wiremold or Thermaflex.

Provide preassembled flexible connections for all ducts that cross building expansion joints. Flexible connections shall be 6" in width as specified hereinbefore. Coordinate requirement with Architectural plans and provide as required.

Externally insulate all flexible connectors to prevent condensation with 2" thickness external duct insulation as specified later in this section. **Do not insulate flexible connectors until installation of the below specified bonding jumper has been verified.**

Prior to insulating, provide copper jumpers across all flexible connectors taking care that jumpers do not bind flexible connections. Provide compression lug and grounding connector screwed into the duct with two (2) screws, on both side of the flexible connector. Bonding wire shall be shielded 12 AWG.

5.19. **Register and Grille Connections:** Where take-offs are in side of a duct, clinch lock short tee sections onto trunk. Install collars with slip joints and 3/4" flange at outlet end. At sheetrock and other hard surfaces, set collars exactly flush with surface.

Install boots above lay-in ceilings simultaneously with ceiling work.

At return air, relief air and exhaust air grilles 36” or more in either dimension, collars shall be 1” x 2” x 1/8 inch steel angle frames with corners mitered, welded and ground smooth. Frames in ceiling shall be independently suspended from the ceiling structure, or the duct shall have special reinforcing to prevent sagging of the boot.

Interior of all ductwork visible through grilles and diffusers shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

5.20. **<u>Hangers and Supports:</u> Duct hangers shall NOT penetrate the external insulation vapor barrier. All duct hanger materials shall be external of the insulation materials, insulation jacket and vapor barriers. All vapor barriers shall be continuous and without penetrations.** All supports, assemblies, related components, attachments and required appurtenances shall be sized for a minimum of 300% (3 times) the anticipated load carried by the respective assembly. Where the Contractor has doubt as to proper supporting requirements, he shall consult with, and seek the guidance of, the Architect and the Project Structural Engineer.

“Sammy” bolts are prohibited. Contractor shall provide supplemental steel between structural purloins, bar joists, etc., for duct support as required to meet support spacing specified. Supplemental steel shall be welded in place as directed and specified by the Structural Engineer. Support small (less than 40 united (w+h) inches) horizontal ducts without external insulation with 1-1/4” x 20 ga. band hangers. Provide in pairs close to each transverse joint and in no case more than six feet apart. Bands shall be turned 3” under the lower corner of ductwork and fastened with one (1) self-tapping screws into the bottom of the duct surface. Bands shall be attached up the sides of the ductwork at a maximum of 6” intervals and in the bottom of the duct. Seal all screws with duct sealer as specified for ductwork.

Support vertical runs larger than 40 united (w + h) inches with structural brackets with welded joints.

Support all non-externally insulated horizontal ducts larger than or equal to 40 united (w+h) inches on trapeze type hanger assembly same as specified below for externally insulated duct except without AP Armaflex surround on the Unistrut. Install inserts or clamps as required to accommodate overhead construction. Spacing shall not exceed 6 feet.

All 14” or less concealed round ducts with external insulation shall be provided with band hangers and saddles. Suspend ducts, at six (6) foot intervals with 8” long, 3” wide, 22 gauge galvanized metal saddles hung from structure with 22 gauge, 1” wide straps. Bands shall pass completely under and around round ducts. Loop strap under duct and attach to strap with two (2) galvanized bolts. Thereafter, loop top end of hanger over steel structural members above and fasten with two (2) galvanized bolts. Where concrete joists occur overhead, secure straps to side of joist with galvanized expansion or ramset bolts. Where flat concrete surface occurs overhead, secure with

ramset or expansion bolt fasteners. See other Specification Sections in the Contract Documents for limitations on use of power driven fasteners.

All concealed and externally insulated rigid round metal ducts greater than or equal to 16", all externally insulated rectangular ductwork, all externally insulated square ductwork, and all externally insulated flat oval ductwork that is specified to have external insulation with a vapor sealed facing **shall be supported with trapeze hangers consisting of Unistrut, threaded rods and inserts or clamps as required to accommodate overhead construction.** Threaded rods shall be of size required to provide support of three (3) times the anticipated load of the assembly. Trapeze hanger assembly spacing shall not exceed 8 feet.

Where ducts are specified to have external insulation with a vapor sealed facing, support duct on trapeze hangers consisting of a Unistrut assembly with threaded rods.

On externally insulated ducts, install 3/4" thickness, **unslit** AP Armaflex insulation of sufficient inside tubular diameter to slide over the Unistrut support, completely cover and snuggly fit to the bottom horizontal Unistrut duct support. The insulation shall extend the full width of the duct plus a minimum of 6", each side. Where channel shapes are used, orient the open side, down. Refer to Part Pipe and Miscellaneous Insulation Work for AP Armaflex material and installation methods specification. Space hangers a minimum of 6" (maximum of 12") from the sides of the duct to permit the duct to be placed within the trapeze hangers.

All concealed internally insulated round ducts shall be supported as specified above for externally insulated ductwork except without saddle. Coordinate exposed duct support requirements with plan details.

Where ducts pass through floors, fill void with fire retardant mineral wool insulation and seal with fire stopping material to prevent the passage of smoke and fire. Thereafter, support duct and close opening with minimum 2"x2"x1/8" steel angles on all sides and, secured to both floor and duct. At plenums and risers just above the floor, provide suitable chair assemblies of welded structural shapes. **Do not install angle iron around opening until Engineer or Architect has verified the proper sealing of the penetration.**

Wherever any duct hanger support exceeds 36" length from the top of the supported duct to the structure above, Contractor shall provide a Unistrut support assembly and provide bracing of the assembly with minimum 1"x1"x1/4" angle iron, or as required for the weight of the particular duct. Weld angle iron to the Unistrut and attach to the overhead structure, as specified and directed by the Structural Engineer, to prevent swaying.

Where ducts rise at the outside walls, the contractor shall provide a welded chair assembly, required supports, attachments and, related and required appurtenances. Duct riser at the outside wall shall maintain a distance between the wall and the finished insulated assembly as required to insulate the back side of the ductwork.

Where horizontal ducts with standing joints exceed 72 inches in width they shall be provided with additional hangers at the mid-point of their width, consisting of a support bolted to an interior 1/8 x 1-1/2 inch strap that shall, in turn, be bolted to the duct. Internal straps and hangers shall be spaced one for each duct section.

Where trapeze type hangers or DuctMate is used to support exposed ductwork in finished areas, the width of the support shall not exceed the duct width by more than six (6) inches on either side of the duct.

5.21. **Roof Relief Hoods/Vents:** Greenheck Series FGI/FGR, Loren-Cook GI/GR, CaptiveAire EV-CA & IV-CA or Carnes Series GI/GE, low silhouette, 18 ga. aluminum or 20 ga. galvanized steel construction unit with welded joints, Hi-Pro Polyester or Lorenized polyester coating with standard or optional premium color selection shall be by the Architect. Hoods shall be certified for use in Florida and comply with all Florida requirements. Hoods shall be complete with 1/2" aluminum bird screen, rain gutter, weather baffle, 10" high (exhaust/relief) height NRCA approved roof curb with built-in cant strip, integral fiberglass insulation and wood nailer. All hoods smaller than 24"x24" shall be hinged type. All exhaust vents shall be 125 MPH rated. Maximum intake throat velocity of 250/500 FPM and .05" WC maximum pressure drop. Maximum relief throat velocity of 600 FPM and .05" WC maximum pressure drop. Hood, throat and curb cap shall be minimum 18ga.

Roof curbs shall be painted with two coats of non-reflective paint. Paint type and color shall be selected by Architect. All roof curbs furnished shall adhere to the roofing Manufacturer's requirements so as not to void the roofing warranty. The top of all roof curbs shall be level with pitch built into curb when deck slopes 3/8 of an inch per foot or more. Coordinate with architectural and structural plans for required slope.

Coordinate roof curb and interface in the building roofing system and verify minimum net height to be as required by Code or as required by Architect. Refer to architectural specification and plans for additional requirements. All roof curbs interfacing shall comply with the Architectural requirements. Coordinate and provide as required.

5.22. **Flexible Air Ducts:** Flexible air duct shall be factory made and composed of an inner duct of woven and coated fiberglass providing an air seal and permanently bonded to coated steel wire helix, a fiberglass insulating blanket and low permeability outer vapor barrier of fiberglass reinforced metallized film laminate. R-value shall be a minimum R=8 per ASTM C-518.

Duct shall be rated for a maximum pressure of 16" (4-10 in. ID) or 10" (12-16 in. ID) water column positive and 2" water column maximum negative pressure and 5000 FPM maximum velocity and Listed by Underwriters Laboratories, Inc., under UL Standard 181 as a Class 1 air duct and complying with NFPA Standards 90A and 90B. Duct shall have a maximum flame spread of 25 and a maximum smoke developed rating of 50.

Flexible duct length shall not exceed six (6) feet. Supply each duct with 1/2" wide, 200 Series **stainless steel worm gear driver and stainless steel band** at take-off fitting and supply fixture connections equal to Thermaflex Snaplock clamp. Zip tying is not allowed.

Suspend ducts, at three (3) foot intervals with 8” long, 3” wide, 22 gauge galvanized metal saddles hung from structure with 22 gauge 1” wide straps. Loop strap under duct and attach to strap with two (2) galvanized bolts. Thereafter, loop top end of hanger over steel structural members above and fasten with two (2) galvanized bolts. Branch duct connectors for connecting round low velocity branches to rectangular low velocity trunks shall be rectangular to round take-off fittings as detailed on the drawings with damper and standoff mounting bracket.

Provide a full size radiused, galvanized sheet metal elbow transition piece from flexible duct connection to each diffuser boot. Elbow gauge shall be as specified hereinbefore in Part, “Sheet Metal Ductwork” for respective duct size.

Flexible duct shall be GreenGuard Level 4 certified, Thermaflex M-KE, ATCO UPC #031 or Flexmaster Type 1M.

PART 6. DUCT INSULATION WORK (EXTERNAL)

6.1. **General: Mechanical Contractor shall not install the external duct insulation.** All external duct insulation work shall be by an experienced insulation subcontractor whose primary business is the installation of insulating materials in accordance with insulation manufacturers’ recommendations and these specifications. Where a conflict exists between these specifications and the Manufacturer’s recommendations, the strictest installation shall be provided.

The finished insulation system shall provide complete thermal barrier throughout the equipment and air distribution system, including effective and durable vapor barriers and vapor stops for any system or condition potentially subject to condensation. Insulation system shall be provided to prevent condensation or potential thereof, to prevent transmission of water vapor into the insulation system (vapor barriers), and to prevent transmission of water vapor within the insulation system should vapor barrier compromises occur during operation and/or maintenance of the building (vapor stops).

Duct must be clean, dry and pressure tested before covering is applied. Cover flexible connections with insulation material as hereinafter specified to same thickness as adjacent duct. All insulation materials (coatings and mastics) shall be fire resistive per NFPA Pamphlet No. 90, ASTM C 411, shall be UL listed and shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84, NFPA No. 255 or UL 723.

Refer to Section Sheet Metal Ductwork, Paragraph Hangers and Supports, for miscellaneous insulating requirements for externally insulated ductwork.

6.2. **Material:** Provide GreenGuard certified glass fiber duct insulation with reinforced foil kraft laminate jacket, formaldehyde-free.

All **supply air** and **return air** ductwork located above the ceiling within the building insulation envelope, in chases and other similar areas shall be provided with **2" thickness, 1.5lb. density, duct wrap with reinforced foil kraft laminate jacket** as specified below.

All **outside air** and **exhaust air** ductwork shall be provided with **1.0" thickness, .75lb. density, with reinforced foil kraft laminate jacket** as specified below. Note that this requirement does not apply to ductwork that is exposed to view in finished areas. Refer to internal duct insulation requirements for duct exposed to view in finished areas.

Thermal conductivity for **1.0" thickness** per ASTM C-518, **0.75 lb. density** shall be not less than k=0.27 BTU·in/(hr·ft²·°F) and minimum installed R=3.0 at 75°F mean temperature with test based on material thickness compressed 25%.

Thermal conductivity for **2" thickness** per ASTM C-518, at its rated thickness, and **1.5 lb. density** shall be not less than k=0.24 BTU·in/(hr·ft²·°F) and minimum installed R=6.3 at 75°F mean temperature with test based on material thickness compressed 25%.

See "Duct Insulation (Internal)" for internal acoustical insulation required in addition to the external insulation specified hereinbefore.

6.3. **Thickness:** Toilets and custodial space exhaust ducts, louver and brick vent plenums, back panels of ceiling diffusers, return air, relief air and exhaust air registers and grilles, and outside air ducts: 1.0" thickness, 3/4 lb. density with reinforced foil kraft laminate jacket. All other locations: Minimum 2.0" thickness and density specified above with reinforced foil kraft laminate jacket. Coordinate with variations specified above for additional layers or 4.25" thickness and provide as required.

Where 2" internal acoustical insulation is specified for ductwork located above the ceiling within the building insulation envelope, in chases and other similar areas, the respective external insulation may be reduced by 1" total thickness with respective density previously specified. See limits of acoustical insulation in Part Duct Insulation Work (Internal) below.

6.4. **Manufacturer:** Johns-Manville Micro-Lite EQ, Type 150 or Type 75 with thickness and density as specified above. Equivalent material by Knauf, Schuller, Owens Corning or CertainTeed will be accepted.

6.5. **Ducts to be Insulated Externally:** Supply air and return air ducts including ducts with acoustical liner, toilet/custodial/housekeeping/janitor closet areas

exhaust ducts, louver and brick vent plenums, short branch duct collar connections to grilles, registers and diffusers, all flexible canvas connectors and exterior rim/cone/panel of all ceiling diffusers, ceiling exhaust grilles and registers and ceiling return registers and grilles. See Part “Duct Insulation Work (Internal)” for sound attenuating insulation requirements of externally insulated ductwork.

Do not externally insulate flexible canvas connectors until installation of the specified bonding jumper has been verified by the Engineer or the Authority having jurisdiction.

6.6. **Application:** Sheet metal duct shall be clean, dry and tightly sealed at all joints and seams before applying duct wrap. Adhere insulation to metal with 4” wide strips of Foster 85-60, ITW Miracle-Kingco M595 Ultratack or Childers CP-127, low VOC insulation bonding adhesive meeting ASTM C916 at 8” on center on circumferential joints. Wrap insulation tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2”. The 2” flange of the facing shall be secured using 9/16” flare-door staples applied 6” on center and taped as specified hereinafter. On longitudinal joints, the overlap shall be secured using 9/16” flare-door staples applied 6” on center and taped as specified hereinafter. For rectangular ducts wider than 23”, additionally support insulation with weld pins and speed clips 18” on center.

Stop and point insulation around access doors and damper operators to allow operation without disturbing duct wrapping. Insulate standing seams and stiffeners that protrude through the insulation with 2” thick, faced, flexible blanket insulation.

Vapor seal all seams, joints, pin penetrations, other breaks, circumferential and longitudinal joints with reinforcing mesh and coat with vapor barrier facing. Mesh shall be **4” wide pre-sized glass cloth** adhered and finished with two (2) coats of a white vapor barrier coating or as required to completely cover the mesh, Foster 30-33, Vimasco 749 or Childers CP-33. **No FSK tape will be allowed.** Fiberglass cloth shall be Great Lakes Textiles Style GL1658, 20x10 thread count per square inch, 0.004-inch thickness and 1.60 oz. /sq. yd., Childers Chil Glas #10 glass mesh, Foster Mast-A-Fab polyester mesh or equivalent product by 3M.

Any externally insulated duct with metallic vapor barrier that is in contact with metallic piping, conduits or metallic structural members shall be provided with a section of Rubatex insulation between ductwork and the metallic member. Rubatex shall be 3/4” thickness, AP Armaflex insulation of sufficient inside tubular diameter to slide over, completely cover and snuggly fit the contacted item. The insulation shall extend the full width of the duct plus a minimum of 6”, each side of the duct. Refer to Part Pipe and Miscellaneous Insulation Work for AP Armaflex material and installation methods specification. The use of AP Armaflex insulation between piping and the ductwork shall only be allowed when raising the effected duct is not an option.

6.7. **<u>Insulation Pins and Washers:</u> The use of adhesives for attaching pins and washers to the ductwork is prohibited.** Pins shall be cupped-head, capacitor-discharge-weld pins, zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135 inch diameter shank, length to suit depth of insulation specified with integral 1-1/2 inch galvanized carbon-steel washer. Insulation retaining washers shall be self-locking type formed from 0.016-inch thick galvanized steel with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

PART 7. DUCT INSULATION WORK (INTERNAL)

7.1. **<u>General:</u>** All work by experienced applicators in accordance with Manufacturer's recommendations and these specifications. Where a conflict exists between these specifications and the Manufacturer's recommendations, the strictest installation shall be provided.

Duct liner, mastics and materials shall comply with all requirements and other building code requirements. All insulation materials (coatings and mastics) shall be fire resistive per NFPA Pamphlet No. 90A and 90B and shall be UL listed and shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Liner materials shall conform to the performance based ASTM C1071, which includes ASTM C518 Thermal Conductivity, ASTM C411 Temperature Resistance, ASTM C665 Corrosiveness, ASTM E84 Surface Burning Characteristics, ASTM C1338 Fungi Resistance, ASTM C1304 Odor Emissions and ASTM C1104 Moisture Vapor Sorption.

7.2. **<u>Material:</u>** Liner shall be a GreenGuard certified, low VOC, Type I liner as defined by ASTM C1071 and characteristics complying with ASTM E 84, UL 723, NFPA 255, NFPA 259 and ASHRAE 62. It shall have an acrylic coating formulated with an immobilized, EPA registered, protective agent to protect against growth of fungi and bacteria as required by ASTM C1071 and tests conducted in accordance with ASTM C 1338, ASTM G21 and ASTM G 22. It shall not support microbial growth and have glass fibers bonded with a thermosetting resin. The airstream surface shall be protected with a reinforced coating with flexible glass cloth reinforcement. The liner shall have a reinforced factory applied edge coating and operate in an environment of a maximum of 250°F and maximum of 6,000 fpm air velocity. Thermal conductivity per ASTM C-518, at its rated thickness, shall be not less than k=0.16 BTU·in/ (hr·ft²·°F) and R=6.3 at 75 F mean temperature in accordance with ASTM C18. Sound absorption coefficients for the liner shall be per ASTM C 423 and ASTM E 795 test methods and the table below. **Furnish sound characteristics for review with the material submittal.**

Sound Absorption Coefficient at Frequency

Thickness	(Cycles per Second)						
(In)	**125**	**250**	**500**	**1000**	**2000**	**4000**	**NRC**
2.0	0.25	0.66	1.00	1.05	1.02	1.01	0.95

7.3. **Manufacturer:** Shall be Johns Manville Linacoustic RC or equivalent material by Schuller, Knauf, Pittsburgh, CSG, Owens Corning or CertainTeed.

7.4. **Thickness:** 2.0 inches thickness.

7.5. **Acoustical Duct Lining:** Line the first ten (10) linear feet of all single wall, supply and return air ducts downstream of all packaged heat pump units and all transfer air (jumper and ATD) ducts with insulation equal to Johns Manville Linacoustic RC and **2.0" thickness.** Sound absorption characteristics shall be as specified above.

Provide metal nosing as specified below when transitioning from 2" thickness to unlined metal. See detail on plans.

7.6. **Application:** Adhere insulation to the entire surface of the sheet metal with fire resistive, low VOC, UL labeled, fire resistive, water based, ASTM C 916, Type II compliant adhesive before the metal is broken. Adhesive shall be Foster 85-60 or Childers CP-127. Secure all sheets wider than 24 inches with sheet metal screws and washers or stud pins and clips 16 inches on center, each way. Joints shall be straight and smooth and shall be buttered with adhesive to prevent erosion and improve airflow. Product shall have factory applied edge coating to assure sealing of transverse edges per current SMACNA and NAIMA installation standards.

Damage to the liner shall be repaired using Johns Manville SuperSeal products as required or equivalent materials by other Manufacturers with their specific equivalent products.

7.7. **Metal Nosings: All exposed leading and trailing edges shall be secured with sheet metal nosings to protect insulation edges**. Metal nosings shall be securely installed over all transversely oriented liner edges facing the airstream at forward and rear discharge towards coils, dampers, ducts, plenums, changes of insulation thicknesses of adjoining insulation, any exposed insulation ends and at any point where lined duct is preceded by unlined duct. See detail on the plans. All remaining miscellaneous exposed edges shall be sealed/coated. There shall be no exposed fiberglass ends in the airstream.

PART 8. REGISTERS, GRILLES AND DIFFUSERS

8.1. **General:** All grilles, registers and diffusers shall be product of a single Manufacturer with baked enamel finish and standard **or** custom color as selected by the Architect. Architect may require painting of the diffusers, grilles, registers, etc., in the field. Where field painting is required, diffusers, grilles and registers shall be factory primed for painting in the field. Refer to Architectural Section "Painting", coordinate requirements and provide finish as required.

Where lay-in ceilings occur, all items specified shall have integral 2' x 2' or 2' x 4' aluminum modular lay-in ceiling panel with finish to match diffuser. Refer to Architectural reflected ceiling plan, check ceiling suspension system, wall and ceiling finishes and provide for proper interface as required.

All ceiling grilles, registers and diffusers not in integral lay-in metal panels and installed in gypsum board or other hard surfaces shall be mounted with aluminum-countersunk screws with finish to match respective items.

All ceiling diffusers, ceiling return air registers and grilles, ceiling exhaust grilles and registers, and ceiling mounted relief air grilles back panels shall be insulated with 1" thickness, foil backed insulation and securely attached. Contractor has the option of insulating manually or furnishing the item with factory furnished insulation from the item Manufacturer. Factory provided insulation shall be attached as shown on the plan details.

All grilles, registers and diffusers shall be ADC or approved equivalent Agency certified.

8.2. **Square Ceiling Diffusers with Round Neck:** Titus Model TMSA-AA, Price ASCDA, removable core type, aluminum construction, with baked enamel standard or custom finish color selected by the Architect, designed for four-way diffusion complete with Titus AG-85, Price VCR8E steel butterfly blade damper. Diffuser face shall be 24" x 24" with type frame to interface with ceiling system. Use lay-in type frame where lay-in ceilings occur.

8.3. **Ceiling Mounted Return Air Registers:** Titus Model 50-F-0-5-D-25, Price Model 80DAL-F-SW-A all-aluminum fabricated egg-crate type, Allen key operated aluminum opposed blade damper and lay-in type frame with baked enamel standard or custom finish color selected by the Architect.

8.4. **Brick Vents for Exhaust Fan Discharge:** Extruded aluminum, Reliable #RBV brick and block vent with 1/4" mesh removable aluminum screen and integral water stop and 50% minimum Kynar finish. Finish shall be factory paint color to be selected by the Architect.

8.5. **Expanded Metal Grilles:** Provide metal grille equal to McNichols Co., flattened expanded metal, galvanized, hot dipped, 3/4, #16 flattened, minimum 70% open (free) area with U-Edging to protect occupants from injury. Grille shall be factory primed for painting in the field as directed by the Architect.

8.6. **Manufacturers:** Equivalents by Titus, Price, Metalaire and Krueger will be accepted. Titus and Price are basis of design.

PART 9. MINI-SPLIT REFRIGERANT PIPING AND ACCESSORIES

9.1. **General:** All refrigerant piping shall be identified. **Note that refrigerant piping will require custom identification.** Refer to Division 20, Identification for requirements.

9.2. **Refrigerant Piping Sleeves:** Refer to Division 20 and plan details and provide sleeves, firestopping and escutcheons as specified for typical piping. Sleeves for pipe passing through exterior walls that contain refrigerant piping shall be Schedule 80, ASTM D1785 PVC pipe, 1/2" larger in diameter than piping and piping covering. Refer to Division 20 and below for requirements.

Coordinate wall sleeve sizes required for refrigerant piping with insulation and aluminum jacket requirements. Piping within wall cavities shall be seamless type with no joints.

9.3. **Piping Diagram:** System shall be complete and sized to conform to current ACRMA standards, except that refrigerant suction risers shall be sized for a gas velocity not less than 2000 fpm.

Various Manufacturers of heat pump mini-split systems have different reasons for the use of loops, traps, accumulators, receivers, etc., in piping arrangements, therefore, submit for review, the air conditioning equipment Manufacturer's recommended, dimensioned plan view and isometric piping diagram proposed for use for each system, showing all valves, loops, pipe sizes and all appurtenances, required for the proper operation of the respective system.

Submit catalog data and Manufacturer's ratings for all valves, catch-alls, etc. with diagram for each system. Identify all items for respective system and list capacities, pressure drops, etc. Secure approval of the heating and air conditioning equipment, and compressor Manufacturer before submitting for review.

Failure to provide the Manufacturers' approved diagram(s) shall make the Mechanical Contractor responsible for all required changes to the piping system and equipment without additional cost to the Owner or his Design Professionals should the installation not be as required by the Manufacturers.

Refrigerant piping support spacing shall be as specified in Division 20. Cut accurately to measurements established at site and work into place without springing or forcing, properly clearing all building features. Arrange and install piping systems, as close as practical, straight, properly supported and run as directly as possible forming right angles or running parallel with building lines, true to line and grade, free of sags and bends. Locate piping as high as practical and in parallel groups as close together as practical. Route through previously built-in sleeves and avoid cutting or other weakening of the structure.

Refrigerant piping for all outdoor units mounted slab on grade shall enter the building at the respective building finish floor and at a maximum of 12" above finish floor of the facility. Contractor shall coordinate final refrigerant piping entrance into the building with the Architect's Field Representative prior to installing any refrigerant piping.

All refrigerant piping, including mini-split piping, shall be Type L hard drawn, ACR copper refrigerant tubing with wrot copper solder joint fittings. **Coiled copper and precharged line sets are NOT allowed unless specifically noted or specified.** All offsets and changes in direction shall be made with 90º or 45° elbows.

Where refrigerant piping is shown rising in the wall cavity and requires modifications to the block wall due to the size of the piping and insulated assembly, the block shall be neatly saw cut. Provide reinforcing to the affected portions of the wall as indicated on the structural drawings and details, the same as required at window and door openings. See the structural drawings for specifics. Extreme coordination is required prior to the erection of the structural slab and wall. Coordinate with the General Contractor.

9.4. **Refrigerant Piping Testing:** Two tests are required. The medium used for pressure testing the refrigerant system shall be oxygen-free nitrogen, helium or argon. Oxygen, air, combustible gases and mixtures containing such gases shall not be used as a test medium. Systems erected on the premises with tubing not exceeding 5/8 inch outside diameter shall be allowed to use the refrigerant identified on the nameplate label or marking as the test medium.

The refrigerant piping system shall be tested as a whole or separate tests shall be conducted for the low-pressure side and high-pressure side of the piping system. The refrigerant piping system shall be tested in accordance with both of the following methods:

Test 1: The system shall be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing shall be the pressure listed on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas shall not be added to the system after the start of the pressure test. The system shall not show loss of pressure on the test pressure measuring device during the pressure test for a minimum 24 hours.

Test 2: A vacuum of 500 microns shall be achieved. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise above 1,500 microns for a period of not less than 60 minutes.

Where using refrigerant as a test medium as specified above, the test pressure shall be not less than the saturation dew point pressure at 77°F.

The International Mechanical Code requires that the installing contractor issue on his company letterhead, to the Local Code Official and the Authority Having Jurisdiction, a certificate of testing for all systems containing 55 pounds or more of refrigerant. The certificate shall give the unit number as shown on the plans, the test date, name of the

refrigerant, test medium and the field test pressure applied to the high pressure side and the low-pressure side of the system. The certification of the test shall be signed by the installing contractor.

9.5. **Joints: Brazed joints only. Flare joints nor press connect joining type systems are allowed.** Joint surfaces shall be cleaned. An approved flux shall be applied where required by the braze filler metal Manufacturer. The piping being brazed shall be purged of air to remove the oxygen and filled with oxygen-free nitrogen, helium or argon. The piping system shall be prepurged with an inert gas for a minimum time corresponding to five volume changes through the piping system prior to brazing. The pre-purge rate shall be at a minimum velocity of 100 feet per minute. The inert gas shall be directly connected to the tube system being brazed to prevent the entrainment of ambient air.

After the pre-purge, the inert gas supply shall be maintained through the piping during the brazing operation at a minimum pressure of 1.0 psi and a maximum pressure of 3.0 psi. The joint shall be brazed with a filler metal conforming to American Welding Society Publication AWS A5.8, Current Edition.

Piping within wall cavities and other inaccessible areas shall be seamless type with no joints.

9.6. **Solenoid Valves (Where Required):** Install in liquid refrigerant connection to the evaporators. Valves shall be designed for the operating pressure and capacity as listed in Manufacturer's catalog with a pressure drop not exceeding 2 psi and shall be sufficient for the requirements of the installation. Install in horizontal runs with body vertical.

9.7. **Expansion Valves (Where Required):** Properly sized diaphragm or bellows type, with external superheat adjustment set for 10 degrees F. superheat. Install in the liquid refrigerant supply lines to the evaporators. Expansion valves up to and including 7-1/2 tons capacity shall be Sporlan Type "S" or approved equivalent. Expansion valves over 7-1/2 ton capacity shall be Sporlan Type "O" or approved equivalent. Install Sporlan full size catch-all filter-drier ahead of valve.

9.8. **Refrigerant Service Valves (DHP Units):** Provide for the proper servicing of the equipment. All refrigerant circuit access ports located outdoors shall be fitted with color coated, all brass, and locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide Owner with minimum of six (6) spare keys.

9.9. **Refrigerant Filter Drier (Catch-all):** Shall be Sporlan, three desiccants type filter drier or approved equivalent. Filter driers up to and including 10-ton capacity shall be sealed type. Filter driers over 10-ton capacity shall be replaceable core type. Units shall have minimum surface filtering area and

capacity not less than that shown in Sporlan Valve Company Bulletin 40-10 or 40-10-8, as applicable, under sizes for “field replacement or field built up sizes”. Careful attention must be given to providing the correct type of filter drier as it pertains to type of refrigerant used in the respective system.

9.10. **Refrigerant Piping Identification:** **Custom factory fabricated refrigerant piping labels are required. Stick-on, painted, stenciled or hand written type identification is not allowed.** The Contractor is urged to carefully review the extensive requirements of Paragraph “Identification” in Division 20 of the specifications and in particular the custom labels and installation requirements prior to certain site visits**.**

9.11. **Miscellaneous Requirements:** Taping or zip tying of liquid lines to suction lines is not allowed. Coordinate wall sleeve sizes required for refrigerant piping with insulation and aluminum jacket requirements.

PART 10. PIPE HANGERS AND SUPPORTS

10.1. **General:** Refer to Division 20 for sleeve/firestopping requirements. **This pipe hanger and support section does not apply to refrigerant piping.** Refer to Part Pipe and Miscellaneous Insulation Work below for refrigerant piping support requirements.

10.2. **Painting of Hangers and Supports:** All non-galvanized and galvanized ferrous metal parts of hangers, piping and related items in mechanical rooms, crawl space, above ceilings, Unistrut and other assemblies used for supporting of ducts (except hanger straps and threaded rods), including black steel pipe, uncoated cast iron pipe, hangers, brackets, etc. shall be coated. All finishes and coatings shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Also, see specification section, "Identification" for additional requirements. Refer to Division 20 for additional requirements.

PART 11. PIPE INSULATION AND MISCELLANEOUS INSULATION WORK

11.1. **General Provisions:** All work by experienced applicators in accordance with Manufacturer’s recommendations and these specifications. Where the specified installation conflicts with the Manufacturers recommendations, the strictest application shall be provided.

Piping must be clean, dry and pressure tested before covering is applied. Size pipe hangers to fit over insulated pipe size. **Hangers and supports shall not be in contact with bare pipe and shall not penetrate the vapor barrier**. See hangers and supports for requirements. Cover fittings, valves and flanges with insulation material as hereinafter specified to same thickness as adjacent pipe covering except screwed unions in hot and chilled piping and other specifically named items. Neatly bevel covering edges adjacent to unions and other points of termination or provide factory fabricated beveled insulation fitting.

All insulation materials including coatings and mastics shall have a composite rating for insulation, jacket or facing, including adhesives, not to exceed 25 flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E-84, NFPA 255 and UL 723.

All piping shall be provided with sleeves/firestopping assemblies. Refer to Division 20 for sleeve and firestopping requirements.

11.2. <u>Refrigerant Suction Lines, All Exterior Refrigerant Piping Including Liquid Lines and Mini-Split System Liquid Lines:</u> Preinsulated refrigerant piping is not allowed unless insulation meets the requirements specified below. Coiled nor precharged line sets are allowed unless noted or specified otherwise. Refer to other portions of this specification for refrigerant piping requirements. All liquid lines located outdoors shall be insulated and installed within the specified aluminum jacket. Refer to aluminum jacket requirements below for additional information.

Insulate with 1" thickness, UL fire and smoke rated unslit, black, flexible foamed, elastomeric, closed cell pipe insulation by AP Armaflex or equivalent by K-Flex or Aerocel AC EPDM. It shall be GreenGuard certified tubular insulation with Microban antimicrobial protection. Insulation shall have a 'k' factor of not more than 0.256 at 90°F mean temperature, water absorption percent by volume of 0.2 and a water vapor transmission rate of 0.05 perm-inches or less.

Slip insulation onto pipe prior to erecting. Longitudinal cutting of the insulation is prohibited. Do not stretch or bend insulation at any turn, tee, etc. Insulate sweat/brazed fittings with miter-cut pieces of insulation as recommended in AP Armaflex installation instructions or, provide factory fabricated, made to order prefabricated fittings for tees, elbows, unions, etc. the same size as on adjacent piping as manufactured by AP Armaflex, Aeroflex Aerofit, K-Flex K-Fit or Aerocell.

On piping with screwed fittings, make up fitting covers from Armaflex with an inside diameter large enough to overlap the insulation on the pipe next to the fitting. Fitting cover shall be long enough to overlap the pipe insulation by a minimum of one inch on each side. Glue the 1" overlap and seal to the adjacent pipe insulation with same adhesive and tape specified below.

Seal all butt joints of insulation and all butt joints at the specified refrigerant piping clamp with AP Armaflex BLV, Black, low VOC, liquid, air-drying contact adhesive. Do not use aerosol adhesive. After gluing joints, wrap all joints with 3" wide, 1/8" thick AP Armaflex self-adhering tape.

All insulated piping shall be continuous without cutting at clamp/support assemblies. All interior refrigerant liquid lines which are <u>not</u> associated with a hot gas reheat coil or liquid lines NOT required to be insulated by the equipment Manufacturer shall not be insulated except, they shall be provided with insulated insert at clamps to Unistrut assemble as specified below.

Note that Various Manufacturers of mini-split and VRF systems require the insulating of refrigerant liquid lines. When required by the Manufacturer, they shall be insulated using materials specified above and in thickness required by the respective Manufacturer. Where the VRF or mini-split system Manufacturer requires less than 1" insulation, install thickness recommended with materials specified above using methods specified below.

11.3. **Condensate Drain Lines Insulation:** To include discharge lines on all equipment specified with or provided with air conditioning condensate drainage pumps. Insulate using same methods and materials as specified for refrigerant piping except 3/4" thickness.

11.4. **Refrigerant Pipe Supports and Clamp Assembly: Do not use clevis hangers for refrigerant piping.** All refrigerant piping, regardless of size, shall be supported with Unistrut assemblies. Provide Unistrut assembly, supporting horizontal refrigerant piping on intervals not exceeding 10 feet. Provide dielectric separation between dissimilar metals. Support piping so that no vibration will be transmitted to the building structure.

Provide an insulated piping clamp assembly at each Unistrut hanger, including the liquid line, suction line and any bare copper line attached to the assembly. The insulated clamp shall provide a crush resistant airtight seal and shall consist of a rigid, closed cell, foam insulation to support tubing and absorb vibration. The outer cover shall consist of a rubber coating that seals the cushion completely after installation to prevent condensation. Clamps shall be steel with electrodichromate finish. Rated assembly temperature range shall be -50ºF to +250ºF. It shall be self-extinguishing as tested under ASTM D 635. After installing device, glue each butt joint and tape each joint with 3" wide, 1/8" thick AP Armaflex self-adhering tape AP Armaflex tape.

Insulated lines shall use ZSi-Foster Series Cush-A-Therm, ArmaFix Eco Light, Aerofix by Aeroflex with clamp assembly or approved equivalent. ZSi-Foster Series Cush-A-Therm is the basis of design.

For units on concrete pad, support piping with rustproof coated, 1-1/2" x 1-1/2" x 1/8" galvanized steel angle supports anchored to pad with steel base plate and bolts. Refrigerant piping shall be attached to the support with the insulating assembly specified above.

11.5. **Condensate Drain Lines Pipe Supports and Clamp Assembly:** To include discharge lines on all equipment specified with or provided with air conditioning condensate drainage pumps shall be provided with an insulated piping clamp assembly. The insulated clamp shall provide a crush resistant airtight seal and shall consist of a rigid, closed cell, foam insulation to support the tubing. The outer cover shall consist of a rubber coating that seals the cushion completely after installation to prevent condensation. Clamps shall be steel with electrodichromate finish. The assembly shall be self-extinguishing as tested under ASTM D 635.

After installing device, glue each butt joint with liquid adhesive and tape each joint with 3” wide, 1/8” thick AP Armaflex self-adhering tape AP Armaflex tape. Spray adhesive is not allowed.

For piping located on the finished floor, support piping with rustproof coated, 1-1/2” x 1-1/2” x 1/8” galvanized steel angle supports anchored to the floor with steel base plate and bolts. Condensate drainage piping shall be attached to the support with the insulating assembly specified above. Insulate using same methods and materials as specified for refrigerant piping (small, chilled water piping) except 1/2” thickness.

Condensate drain lines clamp assembly shall be ZSi-Foster Series Cush-A-Therm, ArmaFix Eco Light, Aerofix by Aeroflex with clamp assembly or approved equivalent.

11.6. **Refrigerant Piping and Condensate Drainage Piping Aluminum Jacket:** All insulated exterior refrigerant piping and all insulated condensate drainage piping terminating in janitor sink, floor sink and hub drains in finished areas and any location that would subject the piping insulation to damage shall be covered with an aluminum jacket.

Where refrigerant piping rises within the wall cavity to above the ceiling, attic or similar space, the aluminum jacket shall terminate within the exterior wall cavity and sealed weather tight to the sleeve in the wall.

The aluminum jacket shall be 18 ga., .04” thick, **smooth finish**, 3003 and 3105 series aluminum conforming to ASTM B-209 standards. Fittings shall be 18 ga., .04” thick, die shaped, and **smooth finish**, Type 1100 aluminum jacket meeting ASTM C585. Provide 1/2" wide, 18 ga., .04” thick, Type 3003 aluminum bands on maximum 24" centers but not less than two bands per jacket section. **Venture Clad or similar product is prohibited.**

Do not install aluminum jacket until refrigerant piping insulation installation has been inspected by the Engineer.

11.7. **Painting and Identifying:** Paint and identify after installation is completed as specified in Division 20, Part Identification. Where piping is specified with an aluminum jacket, painting is not required.

Provide identification on the insulation covering indicating unions. Refer to Division 20, Identification and note special refrigerant piping identification requirements. **Custom factory fabricated refrigerant piping labels are required. Stick-on, painted, stenciled or hand written type identification is not allowed.**

The Contractor is urged to carefully review the extensive requirements of Paragraph “Identification” in Division 20 of the specifications and note that certain identification is required to be completed before certain site visits**.**

11.8. **Submittal Data:** Submit for review complete data on materials and application methods proposed.

11.9. **Manufacturers:** Approved equivalents by Pittsburgh Corning, CertainTeed, Baldwin-Ehret-Hill, Manville, Owens Corning, Armstrong Childers and 3M Company will be accepted.

PART 12. VENTILATION

12.1. **General:** Provide all fans complete with ducts, grilles and required accessories.

All fans shall be certified in accordance with AMCA/ANSI Standards 210 and ANSI/ASHRAE 51. Fans wheels shall be balanced in accordance with AMCA Standard 204-05. Fans shall be UL 705 listed and shall bear the UL Label. Furnish for review capacity and sound power ratings.

All motors 1/2 HP and smaller shall have built-in overload protection.

All motors with scheduled capacity of less than 1 HP shall be ECM type as required by ASHRAE 90.1 and with minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431.

12.2. **Power:** Contractor shall verify all voltage and power requirements with Electrical Contractor, Electrical plans and at the site, prior to ordering equipment.

12.3. **Ceiling Mounted Cabinet Fans:** Penn Ventilator Company Model Zephyr, Series Z-3H thru Z-15H with RA right angle arrangement or TDA arrangement as shown on the plans, or approved equivalent, complete with all accessories, including unit mounted solid state speed control switch, factory baked enamel white metal ceiling grille, metal flanged inlet and outlet connections, acoustically insulated metal housing, direct drive, ECM motors, internally isolated centrifugal fan, integral backdraft damper and terminal cap, cast aluminum brick vent or soffit grille as shown on the plans. Fan wheel shall be steel. Provide aluminum wheel when fan exhausts shower areas. Fan shall be supported from the structure with 1/4” hanger rods, rubber in shear vibration isolators and Manufacturer furnished bracket for attaching rods to the fan and structure above. Refer to plan details for additional requirements.

12.4. **Acceptable Manufacturers:** Cook, Greenheck, Penn Barry. Cook is basis of design.

PART 13. ROOF MOUNTED PACKAGED OUTDOOR HEAT PUMP UNITS (PHP)

13.1. **General Description:** One-piece, high efficiency, combination air-to-air heat pump cooling system and auxiliary electric resistance heating system, premium efficiency motors, powered exhaust and powered relief, complete with automatic controls, primary and secondary condensate drainage stub outs for condensate drainage, removable stainless steel IAQ drain pan,

evaporator coil capillary bulb frostat and powered GFI convenience outlet. All equipment (condenser/compressors) scheduled cooling capacities are based on 95°F ambient temperature. Unit shall be provided with color touchscreen interface with USB port to indicate data trending, historical alarm messages, real-time sensor measurements, on board system setpoints and customized reports. The unit shall be designed for direct, bottom handling of the conditioned air as shown on the plans. **Any unit with arrangement different than shown on the plans requires prior approval.** The equipment shall be shipped completely assembled, pre-charged, piped and wired internally ready for field connections. The Manufacturer shall test operate the unit before shipment. Units shall have heavy-duty metal condenser coil hail guards. The entire unit shall be factory wired for single point power connection.

Where units are shown to be located on the roof, do not route power through the curb. Coordinate requirement with the electrical plans and electrical contractor and provide as specified.

Each unit is specified to be provided with UV-C lights. The unit Manufacturer shall coordinate with the UV-C Manufacturer the placement of the UV-C lights within the unit. UV-C lights shall be placed in number and location as required by the UV-C device Manufacturer for maximum irradiance. The HVAC unit Manufacturer shall provide equipment such that any part subjected to irradiance from the UV lamp system shall be shielded from the UV-C light or constructed of a material that is capable of withstanding UV-C exposure levels expected in provided product without degrading.

Contractor shall verify all voltage and power requirements with Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.

13.2. **Roof Mounted Supports:** Refer to Part Vibration and Noise Control for roof mounted equipment requirements. **Through the base wiring is not allowed.** All items furnished shall adhere to roofing Manufacturer's requirements so as not to void the roofing warranty. Coordinate with architectural and structural plans for required slope. Coordinate roof curb and interface in the building roofing system and verify minimum net height to be as required by Code and Architect. All roof-mounted equipment shall be designed by the Manufacturer and installed by the Contractor to withstand the minimum wind loads prescribed in Florida Codes. Coordinate all requirements with the Structural Engineer prior to installation. Where units are shown to be located on the roof, do not route power through the curb. Coordinate requirement with the electrical plans and electrical contractor and provide as specified.

13.3. **Economizer Package:** All units except PHP-5 shall be provided with a 100% outside air economizer. The economizer shall be provided complete with all controls, powered exhaust, powered relief and air mixing damper assembly consisting of an enthalpy controller, fresh air, recirculated air and exhaust air dampers and protective cover over relief/exhaust unit discharge. The fresh air intake section shall be equipped with 1" thick, washable air filters. The assembly shall mount within the confine of the unit casing. The system shall

be interlocked so that when room thermostat calls for cooling or heating the outside air dampers will return to minimum position.

13.4. **Cooling System:** Total certified cooling capacity not less than indicated in the Equipment Schedule with required items for low ambient head pressure control to 40°F. All compressors shall operate with R-410a refrigerant. Coils shall be of non-ferrous construction with aluminum fins mechanically bonded to seamless copper tubes. Condenser coils shall have sub-cooling rows. The compressors shall be resiliently mounted; have built-in 3-mode crankshaft lubrication, crankcase heater, discharge temperature limiter, current and temperature sensing motor overloads, and five-year guarantee. The system shall be protected by high and low pressure switches, a five minute compressor timed off cycle controller, head pressure controls, reversing valves, accumulator, defrost control system, locking refrigerant charging valves, etc. as required for a complete installation.

13.5. **Hot Gas Reheat Coil:** PHP-1 shall be provided with a refrigerant hot gas reheat coil with modulating reheat coil valve and located in the reheat position. The coil shall be of sufficient size to reheat all of the supply air. Provide, complete, with all necessary valves, controls, etc., as required for a complete and properly functioning installation. Provide manual isolation valves for each hot gas and liquid lines. Furnish for review air conditioning equipment Manufacturer approved refrigerant piping and controls diagram, and statement by the air conditioning Manufacturer on company letterhead that use of the hot gas reheat coil with the equipment is acceptable to the Manufacturer and will not affect any warranty or guarantee. **Equipment submittal will not be reviewed without a Manufacturers' approved diagram and referenced statement**. Minimum reheat capacity for supply air shall be 10ºF. Maximum coil pressure drop is 0.10” static pressure.

Units with a specified cooling capacity of less than 40 MBH shall use the auxiliary resistance heater for reheat. Where the auxiliary resistance heater is specified for maintaining space temperature during dehumidification, the auxiliary resistance heater shall be provided in a minimum of two stages.

13.6. **Auxiliary Electric Heating System:** The electric heater with all components built in at the factory shall carry the UL label. Each coil shall have double thermal protection, consisting of a thermal overload Klixon device and heat limiters in the power legs, current sensing relay, transformer, and timer delay relay. Provide primary fusing, branch circuit fusing per UL and NEC requirements. If backup contactors are used as secondary thermal overload protection in lieu of the fused elements, these contactors shall be built in and prewired at the factory. Resistance wire used in each coil shall be 80% nickel and 20% chromium with no iron content. Wire shall be supported by ceramic bushings, mounted in galvanized steel frame on not more than 4” centers.

Units with a specified cooling capacity of less than 40 MBH shall use the auxiliary resistance heater for reheat. Where the auxiliary resistance heater is specified for maintaining space temperature during dehumidification, the auxiliary resistance heater shall be provided in a minimum of two stages.

13.7. **Fans and Motors:** Supply air fans shall be multi-speed, centrifugal type with premium efficiency motors and permanently lubricated ball bearings, adjustable belt or direct drive high static drive and cfm capacity as indicated.

All units with scheduled cooling capacity of 300,000 BTUH or less shall be provided with direct driven fans with ECM motors.

All motors with scheduled capacity of less than 1 HP shall be ECM type as required by ASHRAE 90.1 and with minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431.

External static pressure indicated on the plans is estimated. The equipment Manufacturer shall provide equipment and motors as required, to match field conditions for the ductwork as installed.

Condenser fans shall be direct driven. All motors shall have inherent protection devices on all legs.

13.8. **Ultraviolet (UV-C) Lights:** Mechanical Contractor is responsible for wiring the devices and providing power for the UV-C lights if not shown on the Electrical plans. Units shall be provided with power supply and connections within the unit cabinet for powering the UV-C lights. Mechanical Contractor shall be responsible for circuitry to UV-C lighting. UV-C lighting shall cycle on and off with the fan or operate continuously as recommended by the UV-C lighting Manufacturer.

Comply with UL / C-UL or ETL for Ultraviolet Fixturing. Store UV-C Fixturing in a clean, dry place and protect from weather, construction traffic and construction debris. UV-C products supplier shall provide proof of 100% inbound and outbound testing of equipment. The UV-C Power supply shall have been tested, listed and labeled as compliant with UL, CSA and CE. Plenum wiring loom shall meet UL Subject 13 and UL 1581, Article 725 of the NEC and meet UL VW-1 material ratings. There shall be a metallic Loom cladding and it shall be UL recognized DXUZ2 and constructed of flexible galvanized steel and cover the entire Loom. Each lamp shall contain no more than 5 milligrams of mercury consistent with current environmental practices. Lamp Watts shall be printed on all lamps, no exceptions. Lamps shall not produce ozone and shall be hermetically sealed within a layer of UV-C transmissible FEP to protect against lamp breakage and to contain lamp contents should breakage occur.

Lamps shall be installed in sufficient quantity and in such a manner to provide an equal distribution of UV-C energy. When installed, the UV-C energy produced shall be of the lowest possible reflected and shadowed-losses and shall produce 360-degree UV-C irradiance from the lamps within the UV cavity. Lamp Watts shall be printed on all lamps, no exceptions. Each lamp shall contain less than 5 milligrams of mercury, consistent with current environmental practices. Lamp useful life shall be a minimum of 9,000 hours with no more than a 15% output loss at the end of the lamp's life (12 months of continuous use). Lamps shall be constructed with UV-C resistant bases and shall not produce ozone. Lamps shall produce the specified output in

moving air of up to 1000 fpm and temperatures of 0-200°F. Lamps shall be hermetically sealed within a layer of UV-C transmissible FEP to provide protection against lamp breakage and to ensure Lamp contents from a broken Lamp, are contained.

Fixture modeling shall be included in the submittal and must contain the necessary calculations to demonstrate that a minimum of 6 lamp watts, as recommended by ASHRAE, are distributed equally to each square foot of coil surface area to achieve a minimum of 100 microwatts per square centimeter equally distributed to the surfaces at the plenum sides, top and bottom. All calculations are to be at 55 degrees F and 500 fpm air velocity, no exceptions.

The power supply housing shall be capable of installation within the air stream, secondary compartment or NEMA enclosure. Lamps shall be mounted to irradiate the intended surfaces as well as all of the available line of sight airstream through proper placement, 360° irradiation and incident angle reflection.

To protect personnel, all unit access panels and doors to the UV-C assembly and/or within view of the UV-C assembly shall include mechanical interlock switches to ensure that the UV-C assembly automatically de-energizes when any equipment access is opened. All UV-C devices shall fit and be installed within the unit cabinet. **Devices shall be hardwired, and UL labeled for the installation. Plug-in devices are not allowed per NEC.** The assembly shall be powered by 120v circuit or as required by the AC unit Manufacturer. Coordinate requirement and provide as required.

A weatherproof redundant disconnect service switch shall be installed to provide a method to more specifically de-energize the UV-C lamp circuits prior to entering the lamp plenum. If not shown on the Electrical plans, the Mechanical Contractor shall provide a redundant disconnect service switch for the UV-C lighting device(s). The disconnect switch shall be a manual single pole, single throw switch mounted beside the Electricals' unit disconnect circuit to nearest receptacle circuit with (2) #12 and (1) #12 Ground in 1/2" conduit.

Provide warning signage on each access point to the UV-C lights and on each side of the unit. Signage materials, methods and colors shall be as specified Division 20, Part Identification. Signage shall read as follows: "***DANGER!! UV-C LIGHT SOURCE! DISCONNECT POWER BEFORE SERVICING UNIT OR UV-C LIGHTING!"*** Do not use stick-on signage provided by the UV-C Manufacturer.

The weatherproof redundant UV-C disconnect switch specified above shall be labeled with materials and methods specified in Division 20, Part Identification. Signage shall read as follows: "***UNIT XX-YY UV-C LIGHTING REDUNDANT SHUT-OFF SWITCH***." XX denotes the unit, and YY is the unit number or type, all as scheduled on the plans.

13.9. **Frame and Casings:** The frame shall be of welded construction. The casing shall be constructed of galvanized hinged panels with hinged latching handles and baked on outdoor acrylic finish. The cabinet bottom shall be insulated with Styrofoam; cabinet panels shall be insulated with 1" fiberglass. All components, wiring and inspection areas shall be completely accessible through hinged panels with locking door handles. Unit shall be provided with a unit Manufacturer furnished heavy-duty metal condenser coil hail guard.

13.10. **Filters:** Provide 2" thick, MERV 11, pleated, disposable type filters for each filter location equal to Farr Series 30/30 and filter access section. All filters shall be common industry standard size filters that are readily available and do not have to be fabricated. Cutting and taping of filter segments to make a proper filter is prohibited. **The Mechanical Contractor shall be responsible for quarterly filter cleaning of the outside air intake filter and quarterly replacement of the return air filters during the guarantee period. The Mechanical Contractor shall inscribe onto the disposable filters' casing the date filters were installed/replaced.**

13.10. **Indoor Thermostat:** Manufacturer shall provide a combination 7-day programmable, two-stage heating automatic changeover heat pump thermostat. Thermostat shall have outdoor thermistor to compensate for thermostat droop, emergency heat switch with indicator light and auxiliary heat light. Thermostat shall have sub-base fan switch for "On-Auto" selection and manual "Heat-Cool" switch. Thermostat shall be hardwired and be provided with battery backup. Coordinate thermostat with specified sequence of operation and provide as required.

Provide hinged metal guard with rounded corners, lock and key for each thermostat.

13.11. **Unit Protection:** All equipment shall also be provided with equipment manufacturer factory installed surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Where manufacturer factory installed devices are not available, protection shall be provided for all 3-phase equipment utilizing ICM Controls Model 450 A Plus+ or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP shall be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor shall consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.

13.12. **Smoke Detectors:** Not required.

13.13. **Factory Start-Up Service:** The Contractor shall provide a factory-trained mechanic, employed by the unit Manufacturer and not a sales representative, to check out all equipment, including hot gas reheat coils and UV-C lights, and furnish written report indicating equipment is installed in strict accordance with Manufacturer's recommendations. Also, provide temperature, pressure

and amp readings taken during testing to substantiate unit performance including the range of the refrigerant hot gas reheat coil valve as applicable.

13.14. **Warranty:** General warranties are specified in Section "General Mechanical Provisions". The Mechanical Contractor and equipment Manufacturer shall provide a non-prorated, total of five years replacement warranty for this equipment, to include all parts and components, belts, lubricants, compressors, refrigerant, etc., all labor and shipping of the items required to return the installation to its original operating condition.

The Mechanical Contractor shall be responsible for any parts, labor, etc. as specified above that is not provided by the equipment Manufacturer.

The Contractor and/or the Manufacturer shall respond within 24 hours upon notification that there has been a failure under the terms of the specified warranty. "Respond" shall mean having a Manufacturer certified technician onsite to evaluate the extent of the needed repairs/replacement and ordering of all items required for repair/replacement.

Shipping of the replacement compressor and any other related unit parts shall be via maximum of 2-day delivery if the unit is inoperable or cannot maintain a minimum indoor temperature of 78ºF to the affected facility.

The warranty period shall begin on the date of substantial completion of the installation, as determined by the Architect, and shall continue for the full product warranty period specified above. Refer to Part, Air Cooled Condensing Units for condensing unit and compressor warranty.

13.15. **Manufacturers:** Trane Series Precedent, Model WHC for units with scheduled cooling capacities of 36,000 BTUH up to and including 120,000 BTUH. Trane Series Precedent, Model WSJ for units with scheduled cooling capacities of 150,000 BTUH up to and including 300,000 BTUH. Trane is the basis of design. Equivalents by Carrier or Lennox will be considered.

PART 14. WALL MOUNTED DUCTLESS SPLIT HEAT PUMP SYSTEM UNIT (DHP)

14.1. **General:** Provide ductless, wall mounted, split system type heat pump unit, equal to Trane/Mitsubishi Electric Series NTXWST/NTXSST for units with specified cooling capacity up to 9 MBH and TPKA/TRUZ units with specified cooling capacity of 12 MBH to 36 MBH complete with all accessories including wall hung evaporator blower unit, pad mounted outdoor condensing unit with lockable refrigerant charging valves, filter frame, filter, fixed, wall mounted, hardwired 7-day programmable, microprocessor electronic thermostat and control module, adjustable discharge louvers, factory installed heavy duty condensate pump (if drainage indicated on plumbing and HVAC plan is not gravity type), low ambient indoor coil thermistor, low ambient control to 14º F, outdoor microprocessor control, heavy duty metal condenser coil hail guard, sweat/brazed connection fittings from the Manufacturer's factory and other accessories required for a complete functional installation. Flare connections are not allowed unless **specifically** required by the

Manufacturer. Refer to Part Condensate Drainage Piping of this specification for drainage requirements. Compressors shall be warranted for 5 years.

All refrigerant circuit access ports located outdoors shall be fitted with color-coded, all brass, locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide Owner with minimum of six (6) spare keys.

14.2. **Refrigerant Piping:** Coiled line sets and preinsulated line sets are not allowed. See other parts of 15700 for piping and insulation requirements. The equipment Manufacturer shall size the refrigerant piping for all the units and shall furnish all accessories and auxiliaries required for a complete and proper installation for the specific application shown on the drawings and the specified sequence of operation. **Piping connections shall be brazed/sweat connections** from the Manufacturer's factory. Flare connections are not allowed unless **specifically** required by the Manufacturer. Refer to Section Refrigerant Piping and Accessories for additional requirements.

All condensate and refrigerant piping that cannot be concealed in the walls in finished spaces shall be provided with Mitsubishi Line-Hide Linset Cover System. Note that this provision shall not be used to cover piping that can be otherwise concealed.

14.3. **Condensate Pump:** Where gravity drainage is not indicated on the plans, condensate pumps for all indoor units shall be Blue Diamond, Series MaxiBlue or approved equivalent. Pump shall be thermally protected, up to 3.7 GPH flow rate, 23 ft. head, 15 ft. suction, self-priming, powered by the indoor unit and maximum 21-db sound level. Pump shall be provided with mounting feet, extension cables and multi-tank configuration as required. Mechanical Contractor to coordinate power requirements for pump, prior to bid, and provide as required.

14.4. **Condensate Drainage:** Refer to Part Condensate Drainage Piping of this specification for drainage requirements.

14.5. **Power Wiring Connection:** Coordinate wiring requirements (separate power for each indoor and outdoor unit or indoor unit powered by outdoor unit) with electrical plans and provide as required.

14.6. **Pad Mounted Supports:** Concrete pad is specified under Division 2 for all units mounted on grade. Where concrete pads are not specified or shown, the Mechanical Contractor shall provide a minimum 4" thickness, 5,000 psi concrete pad with rounded edges and corners. Pad shall extend a minimum of 12" around three (3) sides of the unit and terminate at the building outside wall. Provide a strip of asphalt expansion joint between the concrete pad and the building exterior wall. Expansion joint shall be 1" thickness, non-absorbing, self-sealing, ASTM D 994 compliant and manufactured by W.R. Meadows Inc or equivalent.

14.7. **Unit Protection:** All equipment shall also be provided with equipment manufacturer factory installed surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Where manufacturer factory installed devices are not available, protection shall be provided for all 3-phase equipment utilizing ICM Controls Model 450 A Plus+ or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP shall be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor shall consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.

14.8. **Warranty:** General warranties are specified in Section "General Mechanical Provisions". The Mechanical Contractor and equipment Manufacturer shall provide a non-prorated, total of five years replacement warranty for this equipment, to include all parts and components, belts, lubricants, compressors, refrigerant, etc., all labor and shipping of the items required to return the installation to its original operating condition.

The Mechanical Contractor shall be responsible for any parts, labor, etc. as specified above that is not provided by the equipment Manufacturer.

The Contractor and/or the Manufacturer shall respond within 24 hours upon notification that there has been a failure under the terms of the specified warranty. "Respond" shall mean having a Manufacturer certified technician onsite to evaluate the extent of the needed repairs/replacement and ordering of all items required for repair/replacement.

Shipping of the replacement compressor and any other related unit parts shall be via maximum of 2-day delivery if the unit is inoperable or cannot maintain a minimum indoor temperature of 78ºF to the affected facility.

The warranty period shall begin on the date of substantial completion of the installation, as determined by the Architect, and shall continue for the full product warranty period specified above. Refer to Part, Air Cooled Condensing Units for condensing unit and compressor warranty.

14.9. **Manufacturers:** Trane or equivalent by Mitsubishi, Lennox, LG or Carrier. **Trane is the basis of Design.**

PART 15. AUTOMATIC CONTROLS

15.1. **General:** Furnish and install a complete system of automatic temperature controls, as specified herein, as shown on the Drawings and as required for a complete installation. All temperature control equipment shall be of the electric type. All specified Sequences of Operation are subject to all

equipment built-in safety requirements. Equipment safety requirements shall not be overridden.

15.2. **Submittals:** The temperature control contractor shall submit a complete set of temperature control diagrams with written "sequence of operation" and factory-printed specification data sheets covering each control device proposed to be used for Engineer's review prior to installation of any equipment or part of system. Submittal data shall include a schedule of all devices to be installed.

15.3. **Installation:** By trained and experienced mechanics. All work shall be done by an approved, independent HVAC Controls Contractor whose primary business is the installation and servicing of HVAC controls systems. The HVAC Controls Sub-Contractor shall have an adequate service facility to provide complete service and maintenance of the facility within 100 miles of the installation.

15.4. **Identification:** Provide permanent nameplates for all control components and for all motor starters. Nameplates shall be engraved laminated plastic with letters sufficiently large to be legible under normal operating conditions. Refer to Division 20, Identification for additional requirements, nameplate materials, etc.

15.5. **Conduit, Controls Wiring and Instrumentation Cable:** The HVAC Controls Contractor shall be responsible for the furnishing and installation of a complete and functional system as specified, shown on the plans and as required to accomplish the specified sequences of operation.

All HVAC control cabling and wiring shall be in EMT conduit (no “whips”) or on J-hooks. Above accessible lay-in ceilings, control wiring shall be installed on J-Hook assemblies. Above all hard, inaccessible ceilings, in all mechanical rooms and in areas with exposed structure (no ceilings), controls wiring shall be in conduit. Do not attach any wiring, cabling or conduits to refrigerant piping.

Do not route control wiring through sleeves containing piping. Do not route control wiring through sleeves containing piping. **All control wiring penetrating any exterior wall, interior partition, floor, and similar construction shall be in EMT conduit.** EMT control conduit shall be as specified in the Electrical Division of the specifications and/or as shown on electrical drawings. Minimum HVAC Controls conduit size shall be 3/4” in size. All control conduit, power, relays, contactors, transformers, wiring, etc., required for a complete functional system as specified, shown on the plans, or as required to accomplish the specified sequences of operation, which is not shown or specified by the Electrical Division, shall be furnished and installed by the HVAC Controls Contractor. This shall include all power, interlock control wiring between the various components of the heating, ventilating and air conditioning system, lighting interlocks and all smoke detection system electrical wiring.

Instrumentation cable shall be minimum AWG as specified or heavier AWG as recommended by the controls system Manufacturer.

All thermostat and humidistat boxes shall be mounted 46" A.F.F. to the center of the box (ADA height). Where wall mounted CO_2 Sensors are indicated, they shall be mounted 58" A.F.F to the center of the box.

15.6. **Space Thermostats:** Space thermostats shall be 7-day programmable, microprocessor based, low voltage type with "Heating - Cooling" and fan "On-Off-Auto" switches sub-base. Coordinate thermostat requirements and options with Mechanical Contractor and provide as required to accomplish specified sequence of operation. Each thermostat shall have building power supply with transformer and battery back-up power.

Provide hinged metal guard with rounded corners, lock and key for each thermostat.

All thermostat boxes shall be mounted 46" A.F.F. to the center of the box (ADA height). All thermostat boxes in walls or partitions shall be sealed/caulked to prevent the passage of air and smoke thru the device.

15.7. **Humidistats:** Heavy-duty industrial type. Provide metal guard as specified for thermostats. At his option, the unit Manufacturer/Controls Sub-Contractor may provide a combined thermostat/humidistat device. Coordinate requirement with the equipment manufacturer prior to bid and provide as required.

All humidistat boxes shall be mounted 46" A.F.F. to the center of the box (ADA height). All humidistat boxes in walls or partitions shall be sealed/caulked to prevent the passage of air and smoke thru the device.

15.8. **Smoke Detectors:** Not required.

15.9. **Condensate Drainage:** Refer to Part Condensate Drainage Piping of this specification for drainage requirements.

15.10. **Typical Packaged Heat Pump Unit (PHP) Systems Sequence of Operation:** The control circuit for each unit shall be energized by its respective 7-day programmable thermostat. Occupied and unoccupied schedules shall be programmed by the Controls/Mechanical Contractor as desired by the Owner.

Thermostat shall be used to control heating and cooling. Provide for each heat pump unit an adjustable outdoor thermostat and wire to control the second stage of the auxiliary electric resistance heater.

Upon a call for the occupied schedule, the outside air damper shall open to its minimum scheduled outside air setpoint, and the unit shall start. Upon unit shutdown, the motorized outside air damper shall close.

Upon a call for the unoccupied schedule, the outside air damper shall remain closed, and the unit shall start.

Provide a space humidistat to override the cooling thermostat to provide for dehumidification.

Where specified or humidistats are indicated on the plans, units with a scheduled cooling capacity greater than or equal to 42 MBH shall utilize the specified hot gas reheat coil for reheat. Units with a specified cooling capacity of less than 42 MBH shall use the auxiliary resistance heater for reheat.

During dehumidification, the heat pump unit reversing valve shall be locked out to prevent switching to the heating mode and the compressor shall be commanded on for cooling. The space thermostat shall then modulate the refrigerant hot gas reheat coil valve or the first stage of the 2-stage heater, as specified above, to maintain the required space temperature.

15.11. **Packaged Heat Pump (PHP) Unit Economizer Cycle:** Units are specified with factory mounted enthalpy-based economizer. Sequence of operation is pre-programmed based on ASHRAE requirements. The Controls Sub-Contractor shall verify factory plug and play settings for region of the installation as required. Refer to equipment specifications and coordinate for proper interface as required.

15.12. **Exhaust Fan (EF) Controls:** Provide interlocks for certain fans as noted on fan schedule, including lighting interlocks if not shown on electrical.

15.13. **Time Delay Controls:** Provide time delay control systems as required to stage units starting to prevent more than three units from starting at the same time.

15.14. **Miscellaneous Controls:** Provide all other miscellaneous controls, wiring, dampers, valves, etc., as required for a complete functional control system.

15.15. **Service and Guarantee:** After completion of the installation, adjust all control equipment and place the complete system in operation subject to the review of the Engineer. Guarantee the control system to be free of defects and adequate to provide required control functions for a period of one year after acceptance of project. Provide free service and maintenance during the guarantee period.

END OF SECTION