

# Lazarus House Addition

## Project Manual

cre8 Project 15-006

01 April 2019

**cre8 Architects**

3815 Montrose Boulevard

Suite 123

Houston, Texas 77006

# Addition to the Lazarus House

## Project Manual

cre8 Project 15-006

11 January 2018

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4106 AUSTIN STREET  
HOUSTON, TEXAS 77004

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### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

### 1.2 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. Drawings and Specifications are intended to be complimentary. Any work exhibited in either of them whether in the other or not, is to be executed according to true intent and meaning thereof, the same as if set forth in all. Should any work required by the drawings and specifications be in violation of any Federal, State, County or City laws, ordinance or regulation, those laws and regulations shall prevail, and shall be complied with by the Contractor as a part of this work with no extra compensation.
- B. The drawings are schematic in nature, but show the various components of the system approximately to scale and indicate how they are to be integrated with other parts of the building. Determine exact locations by close coordination with the Owner's Representative, job measurements, determining the requirements of other trades and reviewing all contract documents. The Drawings indicated general routing of the various parts of the systems, but do not indicated all fittings, offsets and runouts which are required. The Contract includes these items as required to fit the system into spaces allotted for them.
- C. Equipment that is scheduled is the basis of the design, and have been coordinated for space, installation and electrical requirements. Space, installation and electrical requirements for other equipment and models from acceptable manufacturers have not been verified or coordinated. Contractor shall verify these requirements prior to using other equipment in his bid and include any additional costs for installation of the equipment. This includes general construction and MEP costs.

### 1.3 PERMITS AND FEES

The contractor shall obtain and pay for all permits and licenses, file all notices, pay all legal fees and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work specified or shown on the drawings. This applies to Federal, State and Local Codes and Requirements. Approval to the various insuring and inspection authorities shall also be obtained. Refer to Architectural sections for additional information.

### 1.4 GUARANTEE

All materials, apparatus and equipment furnished and installed under this Section of these Specifications shall be new and free from any defects when accepted by the Owner and shall be guaranteed in writing for a period of one year from the date of acceptance by the Owner unless noted to have extended warranties.

## 1.5 COOPERATION

The Contractor shall cooperate with other trades on the job and make installations in the proper sequence during the construction of the buildings, and he shall notify the Architect well in advance of construction of all interference of his work with that of other trades and of building construction. This notification shall not relieve the contractor of his responsibilities.

## 1.6 VISITING THE SITE

The Contractor shall be familiar with the Drawings and Specifications and shall have examined the premises and understand the conditions under which he will be obligated to operate in performing the contract. No allowance shall be made consequently for any error through negligence in this regard.

## 1.7 WORKMANSHIP

All work shall be performed in a neat workmanlike manner and in the best practice of the trade. Only workmen skilled in the trades shall be employed to perform the work included in these specifications.

## 1.8 MATERIALS

- A. Materials, when not otherwise definitely specified, shall conform to applicable National Specifications and Standards. All materials shall be certified to not contain any asbestos or other material banned by the Environmental Protection Agency. Lead shall not be used in any material, pipe or solder in contact with the domestic water system.
- B. The names of manufacturers and model numbers have been used in the Contract Documents to establish type of equipment and standard of quality. Where only one name is mentioned for a particular item of material, then that manufacturer is the only one acceptable. Where several names are mentioned, any one of those listed may be furnished provided submittal contains sufficient information to show complete compliance with contract Documents. No attempt has been made to determine if each manufacturer listed will produce material that will comply with all requirements of this project or will fit the allotted space; if they do, then it will be acceptable.
- C. Requests for substitution during the bidding period, in accordance with the requirements of the Special Conditions, must be accompanied by a complete product submittal with all features, accessories and capacities noted. Large equipment must include a 1/4" scale drawing showing how the equipment and required access space are compatible with the available space. Acceptance for bidding does not waive the post bidding requirement for formal submittal and approval.

## 1.9 REMOVAL OF RUBBISH AND CLEAN-UP

Keep area of operations free from accumulation of waste material or rubbish at all times. At the completion of the work, remove all rubbish, tools, scaffolding and surplus materials from the area of operations. The exposed parts of the Mechanical installation which are to be painted shall be thoroughly cleaned of cement, plaster, grease, oil spots and other materials in preparation for painting. All piping shall be cleaned of cement, plaster and other construction debris prior to being concealed above accessible ceilings or being insulated. Clean exposed piping prior to final inspection. All construction areas shall be left "broom" clean on a daily basis. Prior to final acceptance, vacuum clean all mechanical rooms including equipment.



#### 1.10 OPERATION TESTS AND ADJUSTMENTS

After completion of the work and before final acceptance thereof, the Contractor shall notify the Architect when he is ready for the balancing of air and hydronic systems which will be performed by a professional test and balance firm selected by the Owner as described in Section 23 05 93.

#### 1.11 LUBRICATION

After the installation is completed, lubricate all moving parts of all equipment furnished under this Division of the Specifications requiring same. Leave with the Owner a brief but complete set of lubrication instructions, showing the recommended frequency of lubrication and the type of lubricant recommended for each piece of equipment.

#### 1.12 NOISE AND VIBRATIONS

The Contractor shall guarantee that the entire system and its component items of equipment, as installed by him, shall operate without objectionable vibration or noises, as determined by the Architect. If, in the opinion of the Architect, objectionable vibration or transmission thereof to the building occurs, the Contractor shall execute such remedial measures as are necessary to eliminate such unsatisfactory operating conditions and the material and labor thereby required shall be performed at the Contractor's expense.

#### 1.13 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. ELECTRICAL: Power wiring is specified in the Electrical Section. Interlock and control wiring (any voltage) is specified under this Section. Controllers and starters, unless part of a motor control center, are specified under this Section.
- B. PAINTING OF EQUIPMENT, PIPING AND ACCESSORIES: Painting Section. However, all items furnished under this Section shall be kept clean and free from corrosion.
- C. OPENINGS: Various Sections. However, the locations of all inserts and openings shall be determined under this Section and coordinated with other Sections in ample time to avoid cutting new construction.
- D. CUTTING, PATCHING AND FURRING: Various Sections. However, the locations of all inserts and openings shall be determined and coordinated with other sections.
- E. EQUIPMENT AND PIPING SUPPORTS: Refer to structural drawings, details and notes for specific support and pipe hanging requirements. Specific loading and attachment methods shall be followed to assure that individual structural members are not overloaded.

#### 1.14 GENERAL EQUIPMENT REQUIREMENTS

Manufacturer's printed directions shall be followed for preparing, assembling, installing, erecting and cleaning manufactured materials or equipment, unless otherwise directed.

1.15 SHOP DRAWINGS

- A. Submit seven complete sets of shop drawings checked and certified by the contractor as being checked, and lists of materials furnished under this Division. Shop drawings shall be approved before installation of the material under consideration.
- B. Shop Drawings shall consist of published ratings of capacity data, detailed construction drawings, wiring and control diagrams, performance curves, installation instructions, manufacturer's installation drawings and other pertinent data. Where the literature is submitted covering a group or series of similar items, the item under consideration shall be clearly indicated. Ductwork shop drawings shall include one blue-line set and one reproducible set. Drawings shall be submitted showing revisions to equipment layouts due to use of alternate or substitute equipment. The front sheet of each copy of the submittal shall have the following typed information:
  - 1. Job name and location.
  - 2. General Contractor's name, address, Project Manager's name and telephone number.
  - 3. Submitting Sub-contractor's name, address, Project Manager's name and telephone number.
  - 4. Suppliers company name, address, salesman's name and telephone number.
  - 5. Signature of an officer or attorney-in-fact of the Sub-contractor with date and title and a statement that the submittal materials and equipment complies with the Contract Documents.

Any submittal without all of the above information will be rejected without review.

- C. Equipment that has regional representation shall only be supplied by the regional representative that serves the area where the project is located. The regional representative's name and signature shall be included with the shop drawing.
- D. Shop Drawings are required for but are not limited to the following items:

Fan Coil Units	Ductwork	Fans & Roof Curbs
Insulation	Air Devices	Vibration Isolation
Piping Materials	DX Condensing Units	

- E. Approval of these submittals shall not be construed as releasing the contractor from compliance with the contract Documents. They are a means of coordinating the work and aiding in the proper selection and installation of equipment. Do not release items such as fire dampers and starters until associated equipment or ductwork drawings are approved. All materials and equipment shall be subject to final acceptance by the Engineer at the completion of construction and adjustments of the system.
- F. If a submittal is returned to the Contractor marked "Rejected" or "Revise and Resubmit", only one (1) additional submittal will be permitted without the Contractor incurring charges for the additional re-submittals. LTY shall be reimbursed by the Contractor for any expense in connection with any necessary submission in addition to the two (2) submissions allowed. Contractor will be billed by LTY at a rate of \$125/hr for these occurrences.

1.16 PROTECTION OF EQUIPMENT

- A. Do not deliver equipment to jobsite until progress of construction has reached the stage where equipment is actually needed, or until building is closed in enough to protect equipment from the weather. Equipment allowed to stand in weather will be rejected, and Contractor is obligated to furnish new equipment at no cost to Owner.

- B. Adequately protect equipment (including all Owner-furnished items) from damage after delivery to job. Cover with heavy cloth as required to protect from damage.
- C. Equipment which has been damaged by construction activities will be rejected. Contractor shall furnish new equipment at no cost to Owner.

#### 1.17 CUTTING AND PATCHING

Coordinate the work with other trades to arrange for all holes, chases, and other spaces necessary for the installation of all components of the mechanical systems. Inform the other trades in ample time for these to be provided. Failure to comply with this requirement may necessitate cutting and patching work. If such work becomes necessary, it will be done under this Section of the specifications, and shall conform to all applicable requirements of other Sections of the Specifications.

#### 1.18 STRUCTURAL STEEL

All structural steel used for the purpose of fabricating pipe supports, pipe guides, pipe anchors, equipment supports, and framing for large ducts and plenums, shall conform to ASTM Designation A-36. All steel used for these purposes shall be new, clean, straight and galvanized.

#### 1.19 CONCRETE PADS

- A. All equipment mounted on the floor, including expansion tanks and pot feeder, shall have a concrete house keeping pad. Concrete pads shall be sized for the equipment to be supplied. Pad shall exceed base dimensions by approximately 4" all around. Reinforce pads rebar including #4 bar around perimeter. Tool pad to form chamfered edge. Nominal thickness shall be 4" except air handling units and indoor chillers shall be 6". Refer to details for outdoor equipment.

#### 1.20 SPARE PARTS LISTS, OPERATING INSTRUCTIONS

At completion of job, furnish three copies of spare parts lists and operating instructions for all equipment furnished under this Division. These lists and instructions shall be published by the manufacturer of the equipment and shall be in good condition. Bind in 3-ring binder with project name.

#### 1.21 TOOLS AND SPARE PARTS

Upon completion of the installation, deliver to the Owner all tools and spare parts that are furnished by the Equipment Manufacturer for use with the equipment furnished under this Contract.

#### 1.22 REFRIGERANT AND OIL

Furnish and install full refrigerant and oil charge in the air conditioning refrigeration systems and maintain it for full term of the guarantee.

### 1.23 RECORD DRAWINGS

Obtain a set of project drawings and keep these at jobsite during construction. During the course of construction, mark on these prints any changes which are made, noting particularly locations for those items which will need to be located for servicing. At completion of job, mark each sheet "Record Drawings", date and deliver to Architect.

### 1.24 OWNER'S INSTRUCTIONS

Provide the following periods of instruction to the Owner's designated personnel upon completion of the system's installation. Provide additional training as noted in individual equipment specifications.

HVAC System - 8 Hours

### 1.25 ALTERNATES

- A. Determine the scope of each specified alternate proposal by carefully reading all Divisions of the Documents. The Bid Form contains information explaining the extent of the construction to be performed under a specific alternate. Alternate proposals, which are not predominantly mechanical in scope, are described in other Divisions of these Documents. Pay particular note to re-roofing items that may necessitate adjustments to existing piping.
- B. Alternative Equipment: Certain types of equipment as listed below require the specified brand and model to be included in the base bid. At the contractor's option, he may propose equivalent equipment from one of the listed alternate manufacturers for one or more of these types of equipment. The contractor shall list in this alternate bid the name of the item, manufacturer's name, model number and the amount to be deducted from his base bid. The following types of equipment shall be bid in this manner:

### 1.26 MEP INSPECTIONS

- A. Contractor shall formally request inspections from LTY to review any and all MEP installations. Inspections shall include but not be limited to: pipe tests, underground installations prior to backfill, rough-in installations, wall cover inspections, above ceiling inspections, final inspection.
- B. Information required from Contractor on each and every request for inspection is as follows:
  - 1. Specific type of test (i.e. hydrostatic test, head pressure test, medium pressure duct test, etc.).
  - 2. Exact location of test (i.e. area of building with wing or room numbers).
  - 3. Description of test (i.e. partial inspection, walls only, chase walls, wall cover, ceiling cover, etc.)
  - 4. Exact time test started (required test time per Project Manual will need to have elapsed prior to LTY inspection). Estimated time test will start will not be acceptable.
  - 5. Pressure reading on gauge at time of request for all pipe tests (provide picture of gauge with request).

6. Verification from General Contractor with name of person that verified, that specific test has been verified by the Contractor and all sub-contractors to meet all requirements of the Specifications and Codes (prior to inspection request).
- C. Contractor shall provide a MINIMUM of 48 hour notice prior to requested inspection time, no exceptions.
- D. INSPECTION REPORTS: After each inspection, LTY will generate an inspection report and distribute promptly. The Contractor will then be given 7 working days from date of report to address all deficiencies listed on the report. The GENERAL CONTRACTOR shall verify that all items on each inspection report have been addressed by their subcontractors in this time period. Once verified the GENERAL CONTRACTOR shall sign-off on each deficiency listed on the report and return the signed-off copy of the inspection report to LTY via e-mail. After the signed-off report is returned to LTY, the GENERAL CONTRACTOR shall request a re-inspection by LTY to close the report. If after 7 working days no re-inspection is requested by the GENERAL CONTRACTOR to close a report, LTY reserves the right to re-inspect whenever our schedule allows, with these re-inspections still being subject to Paragraph E below.
- E. TEST REJECTIONS AND RE-INSPECTIONS: If a test is rejected or a re-inspection of an issued LTY Inspection Report is found to NOT be completely addressed, only ONE (1) additional inspection will be permitted without the Contractor incurring charges for each additional inspection required. LTY shall be reimbursed \$500 by the GENERAL CONTRACTOR for expenses in connection with EACH inspection in addition to the two (2) inspections allowed.

END OF SECTION

## SECTION 23 05 48 – HVAC VIBRATION ISOLATIONS

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.02 GENERAL REQUIREMENTS

Provide the miscellaneous HVAC and Plumbing Equipment materials and services as shown on the Drawings and specified herein.

### PART 2 - MATERIALS

#### 2.01 VIBRATION ISOLATION

- A. GENERAL: All vibration isolation devices shall be designed and furnished by a single manufacturer, or supplier, who will be responsible for adequate coordination of all phases of this work. Submittal data shall show type, size and deflection of each isolator proposed.
- B. CORROSION PROTECTION:
  - 1. All vibration isolators shall be designed or treated for resistance to corrosion.
  - 2. Steel components shall be PVC coated, or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc electroplated. Structural steel bases shall be thoroughly cleaned of welding slag and primed with zinc chromate or metal etching primer. A finish coat of industrial enamel shall be applied over the primer.
- C. SELECTION: Spring deflections listed are static deflection and are minimum requirements. Isolation efficiencies listed are minimum. The springs shall be capable of 30% over-travel before becoming solid (minimum 1/2" clearance at final inspection). All isolators supporting a given piece of equipment shall be selected for approximately equal deflection.
- D. FCU/CCU/FAN:
  - 1. GENERAL: This Section refers to in-line fans and other structure hung fans.
  - 2. FANS LARGER THAN .5 HORSEPOWER: Provide a spring hanger consisting of a rectangular steel box, coil spring, spring cups, neoprene impregnated fabric washer and steel washer. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure. Size for 1½" deflection, 95% efficient.
  - 3. SMALL HORSEPOWER, STRUCTURE MOUNTED FANS INCLUDING CVT BOXES: Provide an elastomeric hanger, consisting of a rectangular steel box and an elastomeric isolation element, which shall be of Neoprene or high quality synthetic rubber with anti-ozone additive. The elements shall be designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the element. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the steel box.

- E. ACCEPTABLE MANUFACTURERS: Amber/Booth, Kinetics, Korfund, Mason, Peabody, Vibra-Sonics, Vibration Mountings and Southeastern Hose.

### PART 3 - EXECUTION

- 3.1 Installation shall comply with manufacturer's requirements and installation details on the Drawings.

END OF SECTION

## SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

### PART 2 - MATERIALS AND METHODS

#### 2.1 EQUIPMENT MARKING

- A. GENERAL: Each piece of mechanical equipment shall be suitably marked with the name as listed on the plans. Name shall be prominently displayed so it may be easily located and read after equipment installation. Pumps may be marked on adjacent piping.
- B. The following equipment shall be marked with decal or stencil painted, 2" high letters:
  - 1. Fans
  - 2. FCU's
  - 3. Air Cooled Condensing Units
  - 5. Branch Selector Units
- C. Install factory made arrow marker on piping in Mechanical Rooms.

#### 2.2 PIPE MARKING

- A. Identify all new system piping. Identify all existing system piping in AHU/mechanical rooms. Use EMED Co. Kwik-Koil Pipe Markers of appropriate legend and background color, complete with direction arrow for insulated indoor piping. Select appropriate size for O.D. of piping including insulation. Markers or arrows not wrapping the full circumference of the pipe shall be tie wrapped in place, otherwise taped at each end. Use stencil on outdoor piping.
- B. Apply markers as follows:
  - 1. At input and output of each piece of equipment inside building.
  - 2. At each valve not in a mechanical room.
  - 3. At every point a pipe enters or exits a wall or floor.
  - 4. At intervals not exceeding 20 feet.
- C. These markers shall conform to OSHA and ANSI A 13.1 Codes. Arrow markers must have same ANSI background colors as their companion pipe markers and wrap completely around pipe with 3" overlap.
- D. Pipe markers and arrow markers shall be provided as follows:
  - 1. Refrigerant Liquid
  - 2. Refrigerant Suction
  - 3. Refrigerant Hot Gas



4. Condensate Line

- E. All piping in mechanical or air handling unit rooms (or insulation if insulated) shall be painted in accordance with the Owner's color code prior to installing pipe markers.

END OF SECTION

## SECTION 23 05 93 – HVAC TESTING AND BALANCING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 GENERAL REQUIREMENTS

- A. The Testing, Adjusting and Balancing will be contracted and paid for directly by the Contractor and will be coordinated with all requirements of Division 23.
- B. The general contractor and appropriate sub-contractors shall turn over the completed job to the TAB contractor before testing begins. The general contractor shall ensure the system is fully operational, has been cleaned and new airfilters installed in all air-handling units prior to requesting the TAB contractor to perform his work.
- C. It shall be the responsibility of the general contractor and appropriate Sub-contractors to cooperate with the TAB contractor in furnishing personnel during the tab to make such adjustments and corrections specified by the Tab, including but not limited to sheave changes.
- D. All instruments shall be in accurate calibration, and shall be calibrated in ranges that will be expected.
- E. The general contractor to furnish reproducible test and balance reports and shop drawings.

#### 1.3 DESIGN CONDITIONS

The air conditioning systems have been designed and the equipment selected to perform as follows:

##### Summer Conditions

Indoor Temperatures	74° F DB	55% RH
Outdoor Temperatures	97° F DB	77° F WB

##### Winter Conditions

Indoor Temperatures	68° F DB
Outdoor Temperatures	27° F DB

## PART 2 - METHODS

### 2.1 GENERAL

The HVAC contractor shall clean and adjust all systems as described in paragraph 2.2.

### 2.2 HVAC

#### A. HVAC CONTRACTOR'S SCOPE OF WORK

1. As a part of this contract, the HVAC Contractor shall make any changes in the sheaves, belts, dampers, valves, pump impellers, etc. required for correct balance as required by the TAB firm, at no additional cost to the Owner.
2. The HVAC Contractor shall provide and coordinate services of qualified, responsible subcontractors, suppliers and personnel as required to correct, repair or replace any and all deficient items or conditions found during the testing, adjusting and balancing period.
3. In order that all systems may be properly tested, balanced and adjusted as required by these Specifications, the contractor shall operate the systems at his expense for the length of time necessary to properly verify their completion including final adjustments, balancing and readiness for TAB firm. This length of time shall be acceptable to the Inspector. Contractor shall provide all devices to verify correctness of operation.
4. Contract completion schedules shall provide sufficient time to permit the completion of TAB firm's services prior to Owner occupancy.
5. The Drawings and Specifications have indicated valves, dampers and miscellaneous adjusting devices for the purpose of adjustment to obtain optimum operating conditions, and it shall be the responsibility of the contractor to install these devices in a manner that will leave them adjusted, accessible and readily adjustable. Should any such device not be readily accessible, the contractor shall provide access as requested by the TAB firm. Any malfunction encountered by TAB personnel and reported to the contractor or to the inspector shall be corrected by the contractor immediately so the balancing work can proceed.

#### B. RELATED WORK

1. The contractor shall have the building and air conditioning systems in complete operational readiness and shall perform all other items as described herein to assist the TAB company in performing the balancing, testing and adjusting of the HVAC systems.
2. For the air distribution systems the contractor shall complete and verify the following:
  - a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated.
  - b. All volume, splitter, extractor and fire dampers properly located and functional. Dampers shall provide tight closure and full opening, smooth and free operation.
  - c. All supply, return, exhaust, transfer grilles, registers, diffusers and terminal units installed, leak tested and operational.
  - d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessive by-pass or leakage of air.

- e. All fans (supply, return, relief and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; overload heater elements to be of proper size and rating; and clean filters installed.
3. The contractor and the suppliers of the equipment installed shall all cooperate with the TAB firm to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiencies or mal-performance. Furnish a list of all motors with nameplate data and size of overload heater installed with motor amperage during operation.
4. During the balancing the temperature regulation shall be adjusted for proper relationship between controlling instruments and calibrated by the Control Manufacturer using data submitted by the TAB firm. The correctness of the final setting shall be proved by taking hourly readings for a period of three successive eight hour days, in a typical room on each separately controlled zone. The total variation shall not exceed 2° F from the preset medium temperature during the entire temperature survey period.
5. In all fan systems, the air quantities shown on the plans may be varied as required to secure a maximum temperature variation of 2° F within each separately controlled space, but the total air quantity indicated for each zone must be obtained. It shall be the obligation of the contractor to furnish or revise fan drives and/or motors if necessary, without additional cost to the Owner, to attain the specified air volumes.
6. The contractor shall assist the TAB firm in performing three inspections approximately 30 days apart within 90 days after occupancy of the building to ensure that satisfactory conditions are being maintained throughout and to correct any unusual condition.
7. The contractor shall assist the TAB firm in performing inspections in the building during the opposite season from that in which the initial adjustments required to produce optimum operation of the system components, to produce the proper conditions in each conditioned space.

#### C. STORAGE

The contractor shall provide the TAB firm a secure area of ample size, conveniently located for storage of tools, equipment and other items as required.

#### D. NOTIFICATION

1. Systems shall be complete and in operational readiness prior to notifying the Owner that the project is ready for the services of the TAB firm and the contractor shall so certify in writing to the Owner that such a condition exists.
2. Should the Owner be so notified and the TAB work commence and the systems are found to not be in readiness or a dispute occurs as to the readiness of the systems, the contractor shall request an inspection be made by the Owner. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the notification to have been premature, all costs of the inspection and work previously accomplished by the TAB firm shall be paid for by the contractor. Furthermore, such items as are not ready for TAB services shall again be re-tested. Complete, operational readiness, prior to commencement of TAB services, shall include the work described in RELATED WORK above.

### 2.3 HVAC TESTING, ADJUSTING AND BALANCING

- A. The testing, adjusting and balancing of the air conditioning systems will be performed by an impartial technical firm whose operations are limited only to the field of professional TAB. The TAB work shall be done under the direct supervision of a qualified engineer employed by the TAB company. Work shall be in accordance with procedures and techniques as outlined in the ASHRAE Systems Handbook on TAB and procedural standards for TAB, National Environmental Balancing Bureau.
- B. The TAB firm shall be responsible for inspecting, adjusting, balancing and tabulating the data on the performance of fans, all dampers in the duct systems, all air distribution devices and the flow of water through all coils. The Mechanical Subcontractor, the various subcontractors involved and the suppliers of the equipment installed shall all cooperate with the TAB firm to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiencies or mal-performance.

H. RESPONSIBILITY OF THE TAB FIRM

- 1. The TAB personnel shall check, adjust and balance the components of the air conditioning system which will result in optimum noise, temperature and air flow conditions in the conditioned spaces of the building while the equipment for the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents, which is the responsibility of the project contractor.
- 2. The tests shall demonstrate the specified capacities and operation of all equipment and materials comprising the systems. Such tests shall be made as are deemed necessary by the Architect to indicate the fulfillment of the contract. The TAB firm shall then make available to the Engineer such instruments and technicians as are required for spot checks of the systems.
- 3. The TAB firm will not instruct or direct the contractor in any of the work. Any proposed changes or revisions in the work shall be submitted to the Architect in writing. The Architect will process the proposal as appropriate.

I. BALANCING SERVICES

- 1. The TAB firm, Architect and Owner will inspect the installation of heating and cooling pipe systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems. The inspection of the work will cover that part relating to proper arrangement and adequate provisions for the testing and balancing. The inspections shall be performed periodically as the work progresses.
- 2. Upon formal notification of completion of the installation and start-up of the mechanical equipment by the contractor, TAB firm will balance, test and adjust the system components to obtain optimum condition in each conditioned space in the building.
- 3. The TAB firm shall be responsible for inspecting, balancing, adjusting, testing and compiling the data on the performance of fans, all dampers in the duct systems, all air distribution devices or heat exchangers, and the water flow through all coils.
- 4. The TAB firm will, fourteen days prior to Final Inspection, as requested by the Owner prepare a copy of the completed Test and Balance Report. The report shall be complete with logs, data and records as required herein and all logs, data and records shall be typed, produced on white bond paper and spiral bound. The report shall be certified accurate and complete. Transmit copy of report to the Owner's Representative and the Architect. The Architect will review and approve the report.

- J. REPORT: After balancing is complete and before calling for final observation, record and submit for record, the following data:
1. Each CCU & FCU:
    - a. Total supply CFM in full cooling.
    - b. CFM of each outlet served by ducted unit.
    - c. Entering and leaving air temperature.
  2. For each supply and exhaust fan:
    - a. Suction and discharge static pressure, total static pressure and total CFM.
    - b. Fan RPM measured by tachometer. Verify rotation.
    - c. Motor nameplate F.L.A., actual amps and voltage.
    - d. CFM of each outlet served by fan.
  3. Each data value that cannot be balanced to meet scheduled design value:
    - a. List the cause of the discrepancy between the actual data and the design value.
    - b. List corrective action that must be taken to meet design value.
    - c. Note that "Not Operating" is not an acceptable entry into the Testing and Balancing report. If a piece of equipment is not operating during the testing and balancing process, TAB firm will contact Mechanical Contractor. Mechanical Contractor will repair system as required. TAB firm will then test and balance the system as specified.

K. REPORT APPROVAL

After report is submitted and reviewed by Engineer, Test and Balance Contractor shall meet Engineer at the site to review balancing problems and perform a random check of data values listed in report. Contractor shall bring all necessary testing and balancing equipment to site necessary to measure values.

END OF SECTION

## SECTION 23 07 13 - DUCT INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 GENERAL REQUIREMENTS

- A. Install all insulation in conformance with manufacturer's recommendations and these specifications.
- B. LEED EQc4.1: Low-Emitting Materials: All interior adhesives and sealants must meet VOC limit requirements of South Coast Air Quality Management District (SCAQMD) Rule #1168.
- C. LEED EQc4.2: Low-Emitting Materials: All interior paints and coatings must meet VOC limit requirements of South Coast Air Quality Management District (SCAQMD) Rule #1113 and Green Seal GS-11 and GS-03.
- D. Insulation materials manufactured by the following list of companies will be acceptable provided their materials conform to these specifications (see Paragraph on Substitution): Armstrong, CertainTeed, Childers, Foster, Insulphen, Knauf, Koolphen, Manville, Owens-Corning, Pabco, Pittsburg-Corning and SPI.
- E. Flame Spread and Smoke Requirements:
  - 1. All jackets, adhesives, coatings, insulating materials and vapor barrier mastics for air distribution systems shall meet the requirements of NFPA Bulletin 90-A with a flame spread of 25 or less and smoke developed rating not higher than 50.
  - 2. All jackets, adhesives, coatings, insulating materials and vapor barrier mastics for piping and equipment shall have a flame spread not higher than 25 and smoke developed rating not higher than 50.
  - 3. All materials containers shall have a U. L. Label.

### PART 2 - MATERIALS AND METHODS

#### 2.1 DUCT INSULATION

- A. GENERAL: Insulate all supply air ducts, return air ducts through un-insulated spaces and outside air ductwork, including kitchen hood supply air ducts and dryer vent. Insulate exhaust ducts down stream of inline fan backdraft damper. Insulate backs of air devices where ceiling above is not used as a return plenum.
- B. DUCTS INSIDE: 2.2" x 3/4" density duct wrap R-6 stapled in place and vapor sealed with matching FSK tape. Wrap around duct with minimum lap of 2 inches each way, staple with 1/2" outward clinch staples 2" on center, secure on bottom of duct with water based, fire retardant adhesive (Foster 85-60 or Childers CP-127). For ducts 24" to 30" wide, provide one row of pins

on bottom of duct, 16" on center. For wider ducts provide one row on bottom of duct for each 16" of width. Trim pins flush with retainer disk. Seal all with tape with Foster 30-80AF vapor barrier coating. For ducts in mechanical rooms, reduce spacing to 12" on center for each 12" of dimension (all sides of duct). Seal joints and seams with 3" wide FSK foil tape, including termination of flex ducts, and coat tape with Foster 30-80AF vapor barrier coating. Where insulation terminates at equipment (AHU, fan coil, VAV box, etc) and where insulation is custom fitted to transitions and elbows, add glass cloth strip adhered with anti fungal Foster 30-80AF vapor barrier coating between equipment and insulation cover. Coating permeance shall be 0.013 perms or less at 43 mil dry thickness as tested by ASTM E96 and meet ASTM D5590 with 0 growth rating.

END OF SECTION



## SECTION 23 07 19 – HVAC PIPE INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 GENERAL REQUIREMENTS

- A. Install all insulation in conformance with manufacturer's recommendations and these specifications.
- B. All interior adhesives and sealants must meet VOC limit requirements of South Coast Air Quality Management District (SCAQMD) Rule #1168.
- C. All interior paints and coatings must meet VOC limit requirements of South Coast Air Quality Management District (SCAQMD) Rule #1113 and Green Seal GS-11 and GS-03.
- D. Insulation materials manufactured by the following list of companies will be acceptable provided their materials conform to these specifications (see Paragraph on Substitution): Armstrong, CertainTeed, Childers, Foster, Knauf, Koolphen, Manville, Owens-Corning and Pittsburg-Corning.
- E. Flame Spread and Smoke Requirements:
  - 1. All jackets, adhesives, coatings, insulating materials and vapor barrier mastics for air distribution systems shall meet the requirements of NFPA Bulletin 90-A with a flame spread of 25 or less and smoke developed rating not higher than 50.
  - 2. All jackets, adhesives, coatings, insulating materials and vapor barrier mastics for piping and equipment shall have a flame spread not higher than 25 and smoke developed rating not higher than 50.
  - 3. All materials containers shall have a U. L. Label.

### PART 2 - MATERIALS AND METHODS

#### 2.1 REFRIGERANT PIPING

- A. GENERAL: Insulate all refrigerant piping.
- B. MATERIAL: 1" thick, closed cell foam insulation with a thermal conductivity (C value) of .27 at 75° F. Insulation shall have a maximum flame spread rating of 25 and a maximum smoke density rating of 50. Chemical composition of material shall not cause or accelerate corrosion or other deterioration of piping. Provide 1.5" thick insulation if pipe is 2½" or larger.

- C. INSTALLATION: Install insulation in accordance with the manufacturer's recommendations using pre-glued slits and butt joints. Visually inspect joints and touchup as necessary with the manufacturer's recommended adhesive. Insulation without pre-glued factory slits shall be installed over piping during fabrication then glued together. Provide UV protective coating for insulation installed outside.
- D. MANUFACTURER: AP/Armaflex, Rubatex or ImcoLock by IMCOA

## 2.02 CONDENSATE DRAINS

Insulate all condensate drain lines with 1" thick AP/Armaflex SS (or equivalence from manufacturers listed above) self-sealing tube insulation.

END OF SECTION

## SECTION 23 23 00 – REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 SUBMITTALS

- A. Provide submittals as outlined in Section 23 00 00 General Mechanical

### PART 2 - PRODUCTS

#### 2.1 REFRIGERANT PIPING

- A. **GENERAL:** Provide for the systems as shown. Submit shop drawing of piping system showing all traps, pipe sizes, and accessories; drawing to be marked "Approved", and signed by an employee of the Application Engineering Department of the unit manufacturer. Do not install piping until this drawing is submitted and approved.
- B. **MATERIALS:**
  - 1. **PIPE:** Type "L" copper ACR tubing.
  - 2. **FITTINGS:** Wrought copper streamlined, long radius sweat fitting.
  - 3. **SOLDER:** Sil-Fos, except on valves use solder recommended by valve Manufacturer. Make joints while pipe is under nitrogen purge to prevent formation of oxides inside piping.
- C. **ACCESSORIES:** Replaceable core type liquid line dryer-strainer sized for system capacity at 2 PSI pressure drop per ARI Standard 710-64, sight glass-moisture indicator, expansion valves, solenoid valves and charging fittings.

### PART 3 - EXECUTION

- 3.1 **EVACUATION:** Completely evacuated of all moisture by applying vacuum pump for a minimum of 24 hours. Moisture indicator must indicate a completely moisture-free condition at a time of final inspection. Vacuum must be maintained at 50 microns to completely dry system and remove non-condensables.
- 3.2 **DIELECTRIC:** Insulate copper pipe from all dissimilar metals, hangers, pipe, etc., with 4 pound/square foot lead shields 6" long wrapped completely around the pipe and placed between hangers and pipe, or elastomeric snubbers of similar design. B-line B1999 vibra cushion and B2000 two piece clamp.

END OF SECTION

## SECTION 23 31 13 – METAL HVAC DUCTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.
- B. LEED EQc4.1: Low-Emitting Materials: All interior adhesives and sealants must meet VOC limit requirements of South Coast Air Quality Management District (SCAQMD) Rule #1168.

### PART 2 - MATERIALS AND METHODS

#### 2.1 DUCTWORK

- A. Furnish and install all supply, return, exhaust, outside air and other ductwork shown, together with splitters, extractors, dampers, etc. All ductwork, supports, bracing, etc. shall be constructed of new grade, lock forming quality, G-60 or better galvanized steel sheets.
- B. Dimensions of duct work shown on Drawings are inside air stream dimensions. Allowances have not been made for duct insulation.
- C. Provide balancing OBD in each zone duct of multi-zone AHU's. Provide adjustable extractors with quadrant lock mechanism equal to Titus AG-45 at all supply outlet taps into trunk duct. Provide conical tap with damper and raised quadrant lock for flexible duct taps, reference detail on the Drawings. Provide adjustable round elbows (0-90°) at ceiling devices connected with flex ducts (not required if Flexmaster self supporting flex is installed).
- D. Ductwork shall conform with current edition of SMACNA "Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning System" and the National Board of Fire Underwriters Pamphlet 90A, plus more stringent requirements of these Specifications. Adjust location of standing seams to clear structural members.
- E. Duct connections to air handling units and fans shall match the outlet/inlet size, or as recommended by the equipment manufacture, including straight lengths of duct before transitions, to minimize system effect losses. Where duct adapters or damper trays are provided with roof fans, duct connections shall match size for a minimum of 36" before elbow or transition.
- F. All duct transitions shall be gradual with a 15° maximum angle as measured from centerline of duct. This includes angled offset, mitered offset, eccentric transition and concentric transition (2 x 15°).
- G. Ductwork shall be constructed to operate at the pressure as specified under "external static pressure" of the associated air handling unit and fan schedule. Ductwork downstream of VAV boxes and fan coil unit shall be 1" static class ductwork. Ductwork operating at .75 to 2.0" shall be 2.0" pressure rated. Primary ductwork from a variable air volume air handling unit shall be constructed in accordance with Section 2.2 Medium Pressure Ductwork.
- H. Square turns shall be equipped with airfoil turning vanes built to SMACNA Standards. Provide radius turns for elbows less than 90°.

- I. Support ductwork with 1" wide x 20 gage galvanized steel straps; 6'-0" maximum centers but not more than allowed by SMACNA. Connect strap to duct with two sheet metal screws on each side of duct and one on bottom. Exposed ducts shall be supported in a manner to provide a finished appearance.
- J. Install duct braces in duct openings to hold shape of duct until grilles, registers and/or diffusers are installed. Then remove duct brace.
- K. Seal all duct joints, adjustable elbows, spin-in taps and any penetrations of the duct such as screws with Elgen Duct Seal-It, Foster 32-19, Childers CP-146, Design Polymeric DP1010 or Hardcast IG601 Iron Grip installed full strength (no dilution). Ductwork subject to moisture (indoors) and not required to be welded, shall be sealed with Foster 32-14 or Childers CP-140.
- L. In areas noted to have round double wall ductwork, provide United McGill Acousti-K27. Outer duct shall be constructed of paintable, 18 gauge galvanized steel. Inner duct shall be perforated galvanized steel. Between the inner and outer ducts install 2" thick fiberglass insulation coated to inhibit growth of micro-biological organisms and to eliminate erosion of fibers.
- M. The minimum distance between the CVT box and the first tap shall be 54". The minimum distance between taps on the same side of the duct shall be 54".
- N. Provide equivalent sized duct of different aspect ration to accommodate ceiling cavity conditions.
- O. Sheet metal contractor shall install control system that are attached to ductwork. This includes control dampers and sensors.
- P. All ductwork sheet metal shall be made in the United States of America.
- Q. Provide access doors for cleaning ductwork before and after coils, filters, fans and dampers. Locate doors so that the minimum numbers possible are used.

## 2.2 PLENUMS AND BLANK-OFF PLATES

- A. Provide plenums at louvers, air handling units, fan coil units and other equipment where return air or outside air ducts are shown to connect. Provide plenums for the mounting fans to louvers. Provide full or partial blank-off plates on return air openings as necessary for properly balancing of system supply air, outside air and return air flows or to cover openings where air transfer is not desired.
- B. Construct plenums with galvanized steel framing members and galvanized sheet steel, cross broken or rigidly braced with galvanized angles. Gages and bracing shall conform to SMACNA recommendations for ductwork of like size. Openings for fans, access doors, etc., shall be framed with galvanized steel angles.
- C. Where access doors are shown, provide hinged doors with #202 Ventlok latch.

## 2.3 SCREENS

Furnish and install screen on all duct, fan, etc., openings which lead to or are outdoors. Screens shall be No. 16 gage, galvanized steel 1/2" mesh bolted into removable galvanized steel frame. Install screens over return air openings between floors.

## 2.4 METAL CLOSURES

- A. Provide metal closures around all openings in floors or walls through which ducts or piping are passing.
- B. Build 3" high by 3" wide concrete "dam" around duct or return air penetrations of mechanical room floors above grade. Floor return air openings without sound attenuator attached shall be covered with 1" x 1/8" welded steel bar grating supported by 2" x 2" x 1/4" angles attached to slab with 3/4" round drilled anchors, 24" on center.
- C. MATERIALS:
  - 1. Where no fire rating required, and where no fire dampers installed: 18 gage galvanized sheet metal.
  - 2. Where fire rating required or where fire damper is installed: Gage of sleeves shall be as required by the conditions of U. L. listing, but not less than the gage of duct. Minimum 18 gage. Install 1½" x 1½" x 1/8" angles around duct on both sides of wall or floor penetration.
  - 3. Sleeves for floor pipe penetrations above grade shall be a section of Schedule 40 steel pipe extending 3" above finished floor and sealed watertight.

## 2.5 SADDLES

Provide sheet metal protective saddles at all pipe supports for insulated piping. Refer to Insulation Section.

## 2.6 DRAIN PANS

- A. GENERAL: Provide drain pan under fan coil units, air handling units, water heaters and other equipment subject to water leakage not mounted on concrete floor in mechanical room.
- B. CONSTRUCTION: 16 gauge galvanized steel suitably stiffened, with minimum 2" perimeter lip and all joints soldered watertight. Provide connection and overflow drain to suitable location.

## PART 3 - INSTALLATION

### 3.1 SHEET METAL SHOP DRAWINGS

Prior to fabrication of any sheet metal, submit Shop Drawings for all ductwork, showing coordination of mechanical, electrical, plumbing and structural components. All crafts shall sign off on final drawings. The shop drawing shall include a construction details booklet (multiple copies), one blueline set of drawings and one reproducible set of drawings. The booklets and reproducible set with comments noted will be returned. Contractor shall provide blueline sets of drawings from the reproducible set for distribution to Owner, Architect and others.

### 3.2 INSTALLATION OF DUCTWORK AND AIR DEVICES

- A. Prior to all work of this section, Carefully inspect the installed work of all other trades and verify that all such work is complete to the point where fabrication and installation of the work of this section may properly commence.

- B. Verify the location of all ducts, structure, piping and equipment. Coordinate the routing of all work with that of other trades prior to installation. Verify that all ductwork will fit spaces indicated prior to fabrication or installation of any ductwork.
- C. Exact location of all registers, grilles or ceiling outlets shall be verified by the Architect before roughing-in. Reference shall be made to reflected ceiling plan in locating ceiling outlets.
- D. Ducts shall be installed in a neat and workmanlike manner.

### 3.3 CONNECTIONS TO LOUVERS

All connections to louvers shall be in a manner that will be watertight. Ductwork behind louver for a minimum of three feet shall have watertight soldered joints and shall be sloped to weep holes in bottom of louver. Duct shall be lapped over bottom louver blade where possible. Make connections to aluminum louvers with dielectric connections.

### 3.4 ADJUSTMENTS AND CORRECTIONS

Balance all systems of ductwork including exhaust systems to obtain the air quantities indicated for each inlet and outlet. Air quantities shall be further adjusted as required to obtain uniform temperatures in the spaces.

END OF SECTION

## SECTION 23 33 00 – AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 SUBMITTALS

- A. Provide submittals as outlined in Section 23 00 00 General HVAC

### PART 2 - PRODUCTS

#### 2.1 DAMPERS

- A. **GENERAL:** Provide dampers where shown on Drawings and wherever necessary for complete control of air flow, including all supply and outside air ducts. Provide multi-blade volume dampers in all zone ducts at multi-zone air handling units. Where access to dampers through a suspended ceiling is necessary, coordinate the proper location of the access doors. Install, mount and connect into ductwork all control dampers furnished under the control contractors supervision.
- B. **SPLITTER DAMPERS:** Shall be constructed of single thickness, 16 gauge galvanized steel, hinged at leaving edge and founded at entering edge, securely riveted or welded to a square operating rod. The length of the splitter damper blade shall be 1½ times the width of the split in the main duct, but not less than 12".
- C. **VOLUME DAMPERS:** Factory constructed of 16 gage galvanized steel for frame and blades. Blades shall not exceed 48" in length or 6" in width, and shall be of the opposed interlocking type. The blades shall be supported on 1/2" diameter rust-proofed axles. Axle bearings shall be self-lubricating ferrule type.
- D. **FLEX TAP CONNECTIONS:** Taps on rectangular low pressure ducts for flexible connections to diffusers, etc shall be 22 gauge, round conical taps with adjustable single blade damper. Damper rod shall be continuous though tap with blade mechanically attached. Provide bearings at each end, and quadrant lock operator with wingnut and 2" standoff bracket for insulation. Refer to detail on the drawings for additional construction details.
- E. **DAMPER ADJUSTING DEVICES:** Each splitter or volume damper shall be fitted with an adjusting device extending beyond external duct insulation.
  - 1. **ACCESSIBLE CEILINGS:** Elgen damper hardware or Ventlok #641 regulators attached directly to duct and location marked in ceiling as approved.
  - 2. **NON-ACCESSIBLE CEILING:** Regulators exposed. Ventlok #666 rods and #607 end bearings.



## 2.2 FIRE DAMPERS

- A. Install fire dampers in all duct penetrations and return air openings in fire rated walls, ceilings, floors and chases. Provide fire damper at each sidewall register or grille. Provide additional fire dampers where specified by local building codes and also where shown on drawings.
- B. Construction shall conform to requirements of NFPA Pamphlet No. 90A with recommended steel sleeves, fusible links, spring catches, non-corrosive bearings, etc., and shall be U. L. labeled.
- C. Fire dampers shall be shutter type providing minimum restriction to air flow. Provide Type B for ducts passing through walls. Provide thinline Type A dampers at sidewall registers. Provide Type B (or Type A of equal free area) dampers at wall openings. Select damper thickness to fit within the thickness of the wall with OBD's or other specified devices. Dampers located in medium pressure ducts shall be compatible with this construction including the specified maximum leakage rate. Install dampers in accordance with conditions of their U. L. listing.
- D. Air devices in U. L. fire rated ceilings shall have compatible U. L. classified ceiling dampers with volume adjustment mechanism and extension collar equal to Ruskin CFD-A. Install complete system including thermal blanket on back of air device in accordance with the U. L. listing.
- E. Acceptable Manufacturers: Greenheck, Nailor, Pottoroff, Ruskin and Safe-Air

## 2.3 ACCESS DOORS TO FIRE AND SMOKE DAMPERS

- A. Provide double wall galvanized steel, insulated access door in duct for inspection and service to fire damper and fusible link. Minimum size shall be 16"x16" with four cam latches unless limited by duct size. Access doors in stainless steel ducts shall be constructed of stainless steel.
- B. Construct access door airtight and conform to recommendations of NFPA and SMACNA.
- C. Opening of access panel shall be within 12" of the damper to allow resetting of the actuator.

## 2.4 FLEXIBLE DUCT

Flexible duct shall be U. L. Listed 181 Class I air duct with fiberglass/aluminum foil inner liner, fiberglass insulation with a C=.23, bi-directional reinforced metalized vapor barrier outer jacket and 6" w.c. pressure rating. The insulating value shall be meet the International Energy Code, minimum R=6. The maximum length between duct and air device shall be six feet. The maximum length between duct and single or double duct mixing box shall be three feet. Flexmaster Type 3M or Thermaflex M-KE. Connect inner liner to duct tap, VAV box, round rigid duct or air device with stainless steel, adjustable bands (hose clamps). Secure outer cover with nylon wire tie strap. Tape edges of outer cover to adjacent insulation or duct with FSK foil tape to present a finished appearance.

## 2.5 FLEXIBLE CONNECTIONS BETWEEN RTU, FCU OR FAN AND DUCTWORK

Flexible connections shall be made from neoprene coated, woven glass fiber material, 30 ounce per square yard, installed air tight with at least 1" slack to insure that no vibration is transmitted from fan to ductwork. Air units with fans that are internally isolated from the housing do not require flexible connections.

## 2.6 ACOUSTICAL LINER

- A. GENERAL: Provide 1" thick acoustical lining in return air ducts and return air plenums. Do not install in any supply air duct or kitchen return air duct.
- B. MATERIAL: Owens-Corning "Aeroflex Duct Liner" or equivalent by CertainTeed; 1½ pound per cubic foot density, neoprene faced, "K" value not more than .27 at 75° F mean temperature difference.
- C. INSTALLATION: Adhere liner, with coated side toward air stream, to all interior sides of duct with 100% coverage of Foster 85-11. Further secure the liner with mechanical fasteners on maximum 12" centers. All edges and fasteners shall be coated with one brush coat of Foster 30-35.
- D. PLENUMS: Plenum interiors exposed to view through louvers and grilles shall be lined and have pins painted flat black.

## PART 3 - EXECUTION

- 3.1 Installation shall comply with manufacturer's requirements and installation details on the Drawings.

END OF SECTION

## SECTION 23 34 16 – HVAC FANS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 SUBMITTALS

- A. Provide submittals as outlined in Section 23 00 00 General HVAC

### PART 2 - PRODUCTS

#### 2.1 MISCELLANEOUS FANS

- A. **GENERAL:** All fans shall be AMCA rated for air and sound. Each fan shall have fan blade and drive guards, disconnect switch and mounting isolators where applicable. Belt drive fans shall have adjustable motor base plates and adjustable cast iron drives sized for 150% of motor horsepower. Dampers shall be aluminum construction with stainless steel shafts and Teflon bushings. Fans and their accessories shall be a prewired assembly from the factory for single point connection by the electrical subcontractor.
- B. **INLINE FANS:** Direct or belt drive as noted with fan wheel and motor assembly mounted on hinged side access panel. Fan wheel shall be aluminum backward inclined, non-overloading centrifugal type with matching deep venturi cone. Interior of housing shall be fiberglass insulated for sound attenuation. Provide automatic belt tensioner and fan installation hardware for application shown.
- C. **ACCEPTABLE MANUFACTURERS:** Cook, Greenheck, Penn Barry and Twin City Fans

### PART 3 - EXECUTION

- 3.1 Installation shall comply with manufacturer's requirements and installation details on the Drawings.

END OF SECTION

## SECTION 23 37 13 – DIFFUSERS REGISTERS AND GRILLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 SUBMITTALS

- A. Provide submittals as outlined in Section 23 00 00 General Mechanical

### PART 2 - PRODUCTS

#### 2.1 AIR DEVICES

- A. Furnish and install louvers, supply, return and exhaust registers, grilles and outlets shown on the Drawings.
- B. All devices shall be all aluminum construction and shall have white finish. Aluminized type corrosion resistant steel with finish having a five year warranty against the formation of visible rust will also be acceptable. Devices in U. L. fire rated ceilings shall be of aluminized steel construction with white finish, suitable for U. L. classification.
- C. All supply outlets shall be equipped with opposed blade volume dampers. Provide Titus Model D-75 for supply diffusers.
- D. The air distribution equipment supplier shall guarantee that each supply, return and exhaust device shall be of the proper design and size to pass the indicated quantity of air into or out of the space involved, with maximum diffusion and without objectionable noise, excessive friction or objectionable air movement at the occupied level.
- E. Registers, grilles and outlets shall be of manufacture, type and capacity as shown on the schedule of the Drawings. Similar devices of other manufacture may be submitted for approval for those items for which a reasonable close substitute is available. Devices must be similar in appearance and their style must be acceptable to the Architect.
- F. If devices other than those shown are proposed, the values for their face velocities, neck velocities and noise levels, DBA or NC, shall not exceed these values for the devices scheduled on the Drawings.
- G. Ceiling outlets shall be of a type compatible with the ceiling in which they are installed and shall have removable core with overlapping cone design to prevent vertical downward projection of air.
- H. Contractor shall check the Architectural Drawings and verify the type of ceiling shown in the various areas to determine the proper type of outlet for the ceiling used.

- I. Air devices in U. L. fire rated ceilings shall have compatible U. L. classified ceiling dampers with volume adjustment mechanism and have U. L. approved fireproofing on device. Dampers connected to flexible ducts shall also have extension collar feature equal to Ruskin CFD-A. Sidewall registers shall have thinline fire damper. Fire proofing devices shall contain no friable or fibrous material in the air stream.
- J. Air diffusers not required to have fireproofing on the back of the diffuser shall be factory insulated suitable for return air plenum installation.
- K. ACCEPTABLE MANUFACTURERS: Krueger, Metalaire, Nailor, Price and Titus.

### PART 3 - EXECUTION

- 3.1 Installation shall comply with manufacturer's requirements and installation details on the Drawings.

END OF SECTION

## SECTION 23 41 00 – AIR FILTERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

#### 1.2 SUBMITTALS

- A. Provide submittals as outlined in Section 23 00 00 General HVAC

### PART 2 - PRODUCTS

#### 2.1 AIR FILTERS

- A. GENERAL: Provide complete sets of air filters for all supply air handling equipment for use during construction. Protect filters during construction with an overlay of polyester filter media. Replace overlay filter media and filters during construction as necessary to protect coils. Install a set of new filters prior to Testing and Balancing of the system. Install a final set of new filters at Substantial Completion.
- B. FILTER MEDIA: Farr Type 30-30 MERV 8 efficiency, pleated, disposable type filter, 1" thick, suitable for face velocity up to 350 FPM with initial resistance not more than .17" w.g. at that velocity. Use .5" w.g. resistance in fan motor selection.

### PART 3 - EXECUTION

- 3.1 Installation shall comply with manufacturer's requirements and installation details on the Drawings.

END OF SECTION

## SECTION 23 63 00 – VARIABLE REFRIGERANT VOLUME DX SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes split-system air-conditioning and heat pump units consisting of multiple evaporator-fan and variable capacity compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

#### 1.2 SUBMITTALS

- A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics including:
  - 1. Piping schematics with intended piping line lengths indicated on the drawings (piping plan to be coordinated between manufacturer and contractor prior to submittal. Generic piping schematics are not acceptable). The manufacturer shall include notes on the piping schematics indicating locations where expansion loops shall be installed.
  - 2. Wiring schematics showing electrical connection requirements, and field control wiring terminations.
  - 3. Field refrigerant charge volume shall be noted along with factory charge. Note schedule limitations.
  - 4. Manufacturer's performance data shall reflect specified conditions. Nominal capacities are not acceptable. Ratings shall allow for piping lengths, scheduled ambient temperatures, etc.
- B. Operation and maintenance data.
- C. Contractor must have completed the manufacturer's installation training. The contractor shall submit a copy of the training completion certificate for the project manager and at least 2 pipe installers with this submittal.
- D. LEED Submittals:
  - 1. Credit EA 4: Manufacturers' product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

#### 1.3 QUALITY ASSURANCE

- A. The units shall be listed by the Electrical Laboratories (ETL) and bear the cETL label.
- B. All wiring shall be in accordance with the National Electric Code (NEC).
- C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings." Provide certified efficiency ratings per AHRI-1230 standard. (DOE Waiver is not acceptable) Scheduled EER and IEER ratings scheduled shall be considered minimum efficiency allowed.

- D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings." Provide certified efficiency ratings per AHRI-1230 standard. (DOE Waiver is not acceptable) Scheduled COP ratings scheduled shall be considered minimum efficiency allowed.
- E. Units shall be designed to operate with HCFC-free refrigerants.

#### 1.4 WARRANTY

- A. All VRF equipment and controls shall be warranted by the manufacturer for a period of 5 years from the date of startup. (Startup not to exceed 6 months from delivery). The warranty shall include both parts and labor and refrigerant. The condensing units shall include an additional 5 years (total of 10 years) of parts only warranty covering the entire condensing unit.
- B. All warranty shall be executed by the manufacturer's authorized representative. Contractor warranty shall not be allowed.
- C. Copies of the warranty paperwork and startup documentation shall be submitted upon close out of the installation.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers. Manufacturer not listed as the basis of design shall submit for prior approval five (5) days prior to the bid date.
  - 1. Daikin AC (basis of design)
  - 2. Mitsubishi
  - 3. Carrier/Toshiba

#### 2.2 GENERAL DESCRIPTION

- A. The variable capacity, heat recovery and/or heat pump air conditioning system shall be a Variable Refrigerant Volume (heat and cool model) split system as specified. The system shall consist of multiple evaporators, branch selector boxes, manufacturer supplied refrigerant joints and headers, a two or three pipe refrigeration distribution system using PID control, and matched variable speed outdoor condensing units. The outdoor unit is a direct expansion (DX), air-cooled heat recovery/heat pump, multi-zone air-conditioning system with variable speed driven compressors using R-410A refrigerant. All zones are each capable of operating separately with individual temperature control.
- B. Where heat recovery is specified, operation of the system shall permit either individual cooling or heating of each fan coil simultaneously or all of the fan coil units associated with one branch cool/heat selector box. See drawings for Branch Selector locations and associated fan coil units.



- C. Branch selector (BS) boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control up to 96 MBH (cooling) down stream of the BS box. The BS box shall consist of five electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the BS box and main processor and between the BS box and fan coils. The BS box shall control the operational mode of the subordinate fan coils. The use of five EXV's ensures continuous heating during defrost, no heating impact during changeover and reduced sound levels. If solenoid valves in the selector box cause a "clicking" sound upon changeover, then the contractor shall be required to provide additional acoustic wrapping of the box until sound levels are acceptable to the owner and engineer.
- D. The indoor units shall be connected to the condensing unit utilizing manufacturer specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable. All joints shall be installed per manufacturer's instructions.
- E. Equipment capacities to meet leaving air temperatures (LAT) and Total and Sensible capacities as scheduled.

### 2.3 EVAPORATOR-FAN UNIT – HORIZONTAL DUCTED

- A. Concealed Horizontal Ducted Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
- B. Indoor unit shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available in capacities scheduled. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8" from the drain pipe opening.
- C. INDOOR UNIT:
  1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
  2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
  3. All refrigerant lines shall be insulated from the outdoor unit.
  4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet.
  5. The indoor units shall be equipped with a return air thermistor.
  6. The indoor unit will be powered with 208V/1-phase/60Hz. (single point)
  7. The voltage range will be 253 volts maximum and 187 volts minimum.
- D. UNIT CABINET:
  1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.

2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. FAN:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipped with an automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

F. COIL:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 18-3/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

G. ELECTRICAL:

1. A separate single point power supply will be required of 208 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. FILTERS:

1. The units shall be provided with an accessory rear return filter housing (field installed). If filter return grills are indicated on the drawing then this accessory is not required.
2. Provide minimum MERV 8 filter during construction. Contractor to install clean MERV 8 filters just prior to owner acceptance.

## 2.4 AIR-COOLED VARIABLE REFRIGERANT VOLUME CONDENSING UNIT

- A. Outdoor units shall be provided for 460/3/60 as scheduled.
- B. VFD Inverter Control – Each condensing unit shall use a high efficiency, variable speed “inverter” compressor coupled with inverter fan motors for superior part load performance. Compressor capacity shall be modulated automatically to maintain constant suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads.
- C. Systems shall use a field installed 16 or 18 AWG, 2-wire, stranded, non-shielded and non-polarized daisy chain control wiring to interconnect the condensing units, branch selectors, and fan coil units.

- D. Systems shall include a self diagnostic, auto-check function to detect a malfunction and display the type and location.
- E. Condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, and refrigerant regulator.
- F. Units shall be capable of operating down to zero degree F ambient air.
- G. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
- H. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
- I. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed milled steel panels coated with a baked enamel finish.
- J. Condenser fan shall be direct drive motors that have multiple speed operation via a DC (digitally commutating) inverter.
- K. CONDENSER COIL:
  - 1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
  - 2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
  - 3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
  - 4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
  - 5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.
- L. COMPRESSOR:
  - 1. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
  - 2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G2-type" with a maximum speed of 7,980 rpm.
  - 3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
  - 4. The capacity control range shall be as low as 4% to 100%.
  - 5. Each non-inverter compressor shall also be of the hermetically sealed scroll type.

6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

## 2.5 BRANCH SELECTOR BOXES (HEAT RECOVERY SYSTEMS)

- A. ISOLATION VALVES - Full port, bi-directional flow isolation valves shall be installed upstream of all Branch Selector boxes. Where multi-port boxes are used, provide isolation valves both upstream and downstream of the box to facilitate isolation of individual fan coil units. Ensure Schrader fitting is positioned on the downstream side of the valve.
- B. Where heat pump systems are used, provide isolation valves at the fan coils.
- C. During simultaneous heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.
- D. CONSTRUCTION:
  1. The Branch Selector boxes shall have a galvanized sheet plate casing.
  2. Each Branch Selector shall house 5 electronic expansion valves for refrigerant control. (Multi-port boxes shall maintain independent EEV construction. Sharing of valves between zones is not allowed)
  3. Where multiple boxes are installed on the same system, the piping shall be such that isolation of one box shall not disrupt refrigerant flow to other boxes. "Pass through" of refrigerant should not be used where isolation for service will prevent usage of other zones.
  4. The cabinet shall contain a subcooling heat exchanger.
  5. The unit shall have a sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
  6. All pipe connections shall be brazed type.
  7. Branch Selectors shall not require condensate drains.
- E. ELECTRICAL:
  1. The unit electrical power shall be 208-230 Volt, 1 phase, 60 Hz.
  2. The control voltage between the indoor and condensing unit shall be 16 Volt DC.

## 2.6 CONTROLS

- A. ZONE CONTROLLER – Each zone/FCU shall include a 7-Day Programmable controller with the following features:
  1. Backlit LCD display. Day of the week as well as time of day configurable for 12/24 hour clock shall be displayed. Display of temperature information shall be Fahrenheit. The controller shall be able to display and adjust room temperature in one degree increments.
  2. The controller shall have COOL, HEAT, FAN ONLY, DRY (dehumidification), and AUTO-CHANGE-OVER modes.
  3. For AUTO change over mode, the controller shall allow independent setpoints for heating and cooling to eliminate wide swings in temperature and unnecessary change over.

Independent setpoint control shall be available at both local controller and the central controller

4. Setback function shall be included with adjustable setback temperature override.
5. The programmable controller shall have the capability of individually disabling the following buttons:
  - a. Menu/OK
  - b. ON/OFF
  - c. Mode
  - d. Fan Speed
  - e. Setpoint Adjustment (Up/Down Keys) (Set point adjustment shall be in 1 deg F increments)
6. The controller shall allow for a local (controller-level) adjustable limitation of user setpoint range.
7. SCHEDULING: (Schedules shall be controlled via the BAS Interface - See control sequence.)
8. The Remote Controller shall display error codes on the screen in the event of a system error.
9. The following Fan Coil Unit sensor values shall be available at the wall mounted remote controller:
  - a. Controller thermister temp
  - b. (Refrigerant) Liquid line temperature
  - c. (Refrigerant) Gas line temperature
10. 48 Hour battery back up of clock/date. All other settings shall be stored in non-volatile memory to ensure that settings are not lost upon power failure.

**B. CENTRAL CONTROLLER**

1. The building shall be installed with a web-enabled factory native central controller in tandem with the BACnet module to facilitate the remote monitoring and control interface to the City's maintenance office. The manufacturer native controller shall provide web users to manipulate the following functions:
  - a. On/Off Control
  - b. Schedule-Adjustment (schedules to be maintained by BAS)
  - c. Mode Selection – See control sequence for heat/cool changeover control
  - d. Setpoint Control (Independent heating and cooling setpoints available)
  - e. Operational Status and Alarm Notifications
  - f. Provide with battery backup and USB port for software updates
  - g. User and Administrator Levels with password protection.
  - h. Customize groups and zones

**C. CONTROL SEQUENCE:**

1. The VRF system shall be provided with required hardware and software to perform the core operational sequences detailed in this section. In addition to the manufacturer's control system, the VRF supplier will provide a BACnet gateway to provide the monitoring and control points to the Building Automation Contractor. The intent of this section is for a fully functional VRF system to be provided to the owner and the BAS system shall monitor only.
2. The VRF manufacturer shall be responsible for all low voltage communication wiring between their components and central controller to facilitate these sequences. If the wiring is done by the installing mechanical contractor and/or the building automation contractor, the VRF manufacturer shall coordinate all wiring requirements.
3. The VRF central controller shall be provided onsite as a touch screen panel located in the administration office (or as directed by the district). It shall additionally be capable of being accessed to the internet via a district provided IP address and Ethernet connection.

All functions detailed below shall be available via touch screen interface and internet access.

4. Display interface: The controller shall provide a floor plan layout of the building with the fan coil icons and temperature information visible on the screen. At commissioning, the fan coil units shall have the tagging updated to provide the applicable room numbers for the as-built installation. The visual interface shall provide clear indication of what fan coil units are connected to which particular condensing unit system.
5. The controller shall combine all indoor units onto a single central controller interface. The central controller shall provide these basic functions per zone:
  - a. Alarm Identification per fan coil unit (also available on the BAS system)
  - b. Min/Max set point limiting
    - 1) Heating set point and cooling set points shall be controlled individually
    - 2) Set points shall be adjustable at the zone level with adjustable limits controlled by the VRF central controller (initial programming shall limit cooling setpoint control to between 72 – 75 deg. Heating initial range to be 69 – 72 deg)
  - c. Occupied/Unoccupied set point control – Each classroom and the library shall be provided with a motion sensor compatible with the VRF system controls (Sensor provided by the VRF supplier). The motion sensor shall be used to facilitate an automatic set point adjustment when a room is unoccupied. During the regular operation hours (determined by the district's central control system) these zones shall control between the above set point limits. When the room is vacant for more than 5 minutes, as indicated by the motion sensor the fan coil unit(s) shall be turned off. The VRF controller shall automatically enable the fan coil unit(s) if the room temperature rises more than 2 degrees above the standard 75 deg cooling set point (adj) or 2 deg below the standard 72 deg heating set point (adj). The unit shall return to normal operation when motion is detected.
  - d. Timed override for after-hours air conditioning: During periods where the building is not in use (determined by the district schedule and BAS system) the fan coil units shall be capable of being turned on at the wall mounted controller. The VRF system shall automatically turn off after 60 minutes (adj) of operation. This shall not require additional programming by the BAS central control system. FBISD Central Maintenance shall have the ability to override the after-hours operation to prevent operation (see applicable portion of the BAS system control sequence)
  - e. When the system is off according to the district schedule, the VRF controller shall cycle the cooling/heating if the temperatures exceed the unoccupied threshold temperatures. (85 cooling & 60 heating)
6. Heat/Cool Automatic Changeover Sequence:
  - a. The VRF manufacturer's controller shall manage the heat/cool changeover automatically. The local thermostat MODE button shall be disabled by VRF central controller. (Central BAS has ability to manually override as needed, but regular management of heat/cool mode shall be performed by VRF Controller)
  - b. Requirement of manual change-over of heat/cool mode is not acceptable.
  - c. Each zone/fan coil unit shall have minor set point adjustment per the zone controller detail above. The central VRF controller shall monitor each fan coil unit connected to the heat pump condensing unit and compare the current temperature

to the unit's set point. The central controller shall make the heat/cool mode changes for the group of fan coils based on the weighted average of their demand.

- 1) Example – All zones are satisfied (system idle) and the system has heating mode enabled. Any fan coil on the system that has a space temperature rise above the active set point will result in a central enabling of the cooling mode.
- 2) Individual fan coil units (or groups) should be capable of being assigned a higher priority if directed. This would allow heating/cooling needs of these units to drive the heat/cool mode changes.

### PART 3 - METHODS

#### 3.1 INSTALLATION

- A. Mechanical contractor must complete an accredited installation training class prior to starting the installation. The contractor's PM and piping foreman must each have certification.
- B. Installation shall be per manufacturer's recommendations. Extra care shall be provided to allow for expansion and contraction of piping. Contractor shall install expansion joints on gas lines per the manufacturer's recommendations.
- C. UNDER NO CIRCUMSTANCE SHALL THE FAN COIL UNITS BE OPERATED BEFORE STARTUP OR WITHOUT SPECIFIED FILTERS IN PLACE.

#### 3.2 FIELD QUALITY CONTROL

- A. The installing contractor shall complete the installation and complete a total system pressure test of 550 psi for 24 hours prior to startup.
- B. THE MANUFACTURER OR MANUFACTURER'S AGENT SHALL BE RESPONSIBLE FOR ALL EVACUATION AND CHARGING OF REFRIGERANT FOR EACH SYSTEM AT STARTUP. CONTRACTOR STARTUP IS NOT ALLOWED.
- C. The manufacturer's agent shall provide the following startup services:
  1. Evacuation of the piping system to a 400 micron vacuum (hold 3 hours)
  2. Proper charging of the system with R-410A **Refrigerant provided and installed by the installing contractor**
  3. Execution of all standard diagnostics.
  4. Connection to the system with the manufacturer's Service Checker software and creating an operational log of the following information for verification:
    - a. Each system operates with proper temperatures, delta T and superheat conditions in both cooling and heating modes.
    - b. Each fan coil unit is heating/cooling properly (verification that piping work has been installed properly).
  5. A digital copy of these operational logs shall be stored by the manufacturer's agent as well as delivered to the owner with warranty documentation.

END OF SECTION