

THE CITY OF WALTHAM
MASSACHUSETTS

PURCHASING DEPARTMENT

**Waltham Community Cultural Center,
HVAC Improvements**

ADDENDUM NO. 3

Oct. 16, 2017

CHANGES, CORRECTIONS AND CLARIFICATIONS

The attention of bidders submitting proposals for the above subject project is called to the following addendum to the specifications. The items set forth herein, whether of omission, addition, substitution or clarification are all to be included in and form a part of the proposal submitted.

THE NUMBER OF THIS ADDENDUM (NO. 3) MUST BE ACKNOWLEDGED IN SECTION 00 10 10 (B) –FORM FOR GENERAL BID.

ITEM 1: ANSWER TO POSED QUESTIONS:

- 1. Please confirm that Section 230000- HVAC is not responsible for any lead remediation requirements for all penetrations.**
 - a. Confirmed**
- 2. Regarding the issue of HVAC disconnects and who owns them; Please clarify whether: HVAC is to furnish unit disconnects and E.C. is to wire or, E.C. is to furnish and install**
 - a. All Electrical Disconnects are to be by EC**
 - b. All Electrical Connections are to be by EC**
- 3. In reference to Section 021120-153,1.01.B. and General Note 8 on Drawnig A1-0. Please confirm who is responsible for the HVAC demolition and to what extent.**
 - a. For interior demolished items follow note 8. For roof top demo removal will be by HVAC contractor.**

4. Please confirm the removal and reinstallation of all existing ceilings for the purpose of installing HVAC pipe, duct and equipment is by Section 095113, Acoustical Panel Ceilings.
 - a. Confirmed

5. In reference to Section 230000, 2.9, H, should the painting of the outdoor exposed refrigeration piping insulation be performed by Section 099000, Painting and Coating and not Section 230000, HVAC?
 - a. This insulation should be finished by manufacturer

6. Can you please provide more information on the technical products required in this project?
 - b. See the following attachment

End of Addendum 3

EQUIPMENT SCGHEДУLE

FCU-107: Server Room; Mitsubishi Model PKA-A12HA6 rated for 12,000BTUH (cooling) electrical rated for 208/1ph. Provide with leak sensor and condensate pump & thermostat (per dwg. H5.01)

SPECIFICATIONS

HVAC WORK section 230000

Modify as follows-

Item 1: Section 1.3 Work Included add the following,
'section 1.03.I.submit and obtain all energy rebates and incentives related to the installed project equipment. All monies are to given to the City of Waltham, no credit allowance on the bid will be allowed to be applied or taken by the bidder.'

Item 2: Section **1.1 FILED SUB-BID** read in part;

E. Sub Sub-Bid Requirements: None under this Section.

1. TESTING ADJUSTING AND BALANCING
2. SHEETMETAL
3. INSULATION
4. AUTOMATIC TEMPERATURE CONTROLS

Delete this section and replace as follows;

E. Sub Sub-Bid Requirements:

1. TESTING ADJUSTING AND BALANCING
2. SHEETMETAL
3. INSULATION
4. AUTOMATIC TEMPERATURE CONTROLS

Item 3: Section **1.8 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION** delete in its entirety and replace as follows;

1.8 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION.

- A. Furnish line voltage fan speed control switches for installation by the Electrical Subcontractor.
- B. All motors for HVAC equipment shall be furnished and set under this section. All motor starters shall be provided by the HVAC Sub-Contractor for installation by the Electrical Contractor.
- C. All controls shall be provided by the HVAC Sub-Contractor for installation by the ATC Sub-Contractor. All control wiring shall be provided and installed by the ATC Sub-Contractor in accordance with the applicable provisions of the specifications.

Item 4: Section **2.3 ACROSS THE LINE STARTERS**, subsection D. revise rating from NEMA 1 to NEMA 4X.

Item 5: Section **2.25 VARIABLE REFRIGERANT VOLUME HEAT PUMP SYSTEM**, delete in its entirety and replace as follows;

2.25 VARIABLE REFRIGERANT VOLUME HEAT PUMP SYSTEM

A. General

1. System shall have the capacities and electrical characteristics indicated on the schedule.
2. The variable capacity, heat pump heat recovery air conditioning system, design based on a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system. The Y-Series system shall consist of PUHY outdoor unit, multiple indoor units, and M-NET DDC (Direct Digital Controls). The sum of connected capacity of all indoor air handlers shall range from 50% to 130% of outdoor rated capacity.
3. System and controls complete start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Mitsubishi Electric controls system configuration and operation. The representative shall provide proof of certification for Mitsubishi Electric Controls Applications Training indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hours.
4. Refrigerant, R410A refrigerant, polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

B. Quality Assurance

1. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
3. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
4. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.
5. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
6. If an alternate manufacturer is selected, any additional material, cost and labor to install additional lines shall be incurred by the contractor.

C. Controls

1. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible

through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

2. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.
3. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
4. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
5. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.
6. System shall be capable of email generation for remote alarm annunciation.

D. Warranty

1. Manufacturer's warranty for a period of ten (10) years parts and ten (10) years compressor to the original owner from date of installation. Contractor to comply with all manufacturers requirements to obtain the above listed warranties.

E. Equipment

1. OUTDOOR UNIT,
 - A. General , the Y-Series PUHY outdoor unit shall be specifically used with CITY MULTI VRF components. The PUHY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped, wired and run tested at the factory.
 - B. The model nomenclature and unit requirements are as scheduled. All units requiring a factory supplied twinning kit shall be piped together in the field, without the need for equalizing line(s).
 - C. Outdoor unit shall have a sound rating no higher than 60 dB(A) individually or 65 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 55 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
 - D. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.
 - E. Both refrigerant lines from the outdoor unit to indoor units shall be insulated.
 - F. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
 - G. The outdoor unit shall have a high pressure safety switch, over-

- current protection and DC bus protection.
- H. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet (294 feet optional) and have a total refrigerant tubing length of 3280 feet. The greatest length is not to exceed 541 feet between the outdoor unit and the indoor units without the need for line size changes or traps.
 - I. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperature or cooling mode down to 23°F ambient temperature, without additional low ambient controls.
 - j. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up.
 - K. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 - l. Unit Cabinet:
 - 1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
 - M. Fan:
 - 1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan.
 - 2. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
 - 3. The fan motor shall be mounted for quiet operation.
 - 4. The fan shall be provided with a raised guard to prevent contact with moving parts.
 - N. The outdoor unit shall have vertical discharge airflow.
 - O. Coil:
 - 1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
 - 2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 - 3. The coil shall be protected with an integral metal guard.
 - P. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 - Q. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.
 - R. Compressor:
 - 1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand

- charges) and require larger wire sizing, shall not be allowed.
2. A crankcase heater(s) shall be factory mounted on the compressor(s).
 3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 18%-4% of rated capacity, depending upon unit size.
 4. The compressor shall be equipped with an internal thermal overload.
 5. The compressor shall be mounted to avoid the transmission of vibration.
- S. The outdoor unit shall be controlled by integral microprocessors.
- T. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
2. WALL MOUNTED. INDOOR FAN COIL UNIT
- A. General:
- The PKFY shall be a wall-mounted indoor unit section and shall have a modulating linear expansion device and a flat front. The PKFY shall support individual control using M-NET DDC controllers.
- B. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- C. Unit Cabinet:
1. All casings, regardless of model size, shall have the same white finish
 2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
 3. There shall be a separate back plate which secures the unit firmly to the wall.
- D. Fan:
1. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
 4. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.
 5. Filter: return air shall be filtered by means of an easily removable, washable filter.
- E. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.
 3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.

6. Both refrigerant lines to the indoor units shall be insulated.
- F. Controls:
 1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system.
 2. The unit shall be able to control external backup heat.
 3. The unit shall have a factory built in receiver for wireless remote control
 4. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 5. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 6. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 7. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
- G. Provide with pan leak sensor for automatic unit shut-off.
3. **FOUR-WAY CEILING-RECESSED CASSETTE, INDOOR FAN COIL UNIT**
 - A. General
 1. Recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
 - B. Unit Cabinet:
 1. The cabinet shall be space-saving ceiling-recessed cassette.
 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 3. Branch ducting shall be allowed from cabinet.
 4. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
 5. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space
 - C. Fan:
 1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 3. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
 4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
 5. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
 6. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
 7. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.

- D. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space. Filter:
 - 1. Return air shall be filtered by means of a long-life washable filter
 - E. Coil:
 - 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.
 - 3. All tube joints shall be brazed with phos-copper or silver alloy.
 - 4. The coils shall be pressure tested at the factory.
 - 5. A condensate pan and drain shall be provided under the coil.
 - 6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.
 - F. Controls:
 - 1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.
 - 2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 - 3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 - 4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 - 5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
 - 6. Provide with pan leak sensor for automatic unit shut-off.
4. FOUR-WAY CEILING-RECESSED CASSETTE INDOOR FAN COIL UNIT
- A. General:
 - 1. The PLFY-P**NCMU-ER4 shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
 - B. Unit Cabinet:
 - 1. The cabinet shall be a compact 22-7/16" wide x 22-7/16" deep so it will fit within a standard 24" square suspended ceiling grid.
 - 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - 3. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
 - C. Fan:
 - 1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. The indoor fan shall consist of three (3) speeds, Low, Mid, and High.
 - 4. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
 - 5. The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.
 - D. Filter:

1. Return air shall be filtered by means of a long-life washable filter.
- E. Coil:
 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.
 3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.
 6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.
- F. Controls:
 1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.
 2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
 6. Provide with pan leak sensor for automatic unit shut-off.
5. ONE-WAY CEILING-RECESSED CASSETTE, INDOOR FAN COIL UNIT
 - A. General:

The PMFY shall be a one-way cassette indoor unit that recesses into the ceiling with a ceiling grille and shall have a modulating linear expansion device. The PMFY shall support individual control using M-NET DDC controllers.
 - B. Indoor Unit.

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
 - C. Unit Cabinet:
 1. The cabinet shall be space-saving ceiling recessed.
 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 3. Branch ducting shall be allowed from cabinet.
 4. The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow.
 - D. Fan:
 1. The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor.
 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 3. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.
 - E. Filter:
 1. Return air shall be filtered by means of a long-life washable permanent filter.
 - F. Coil:
 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.

3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.
 6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 23 inches above the condensate pan.
- G. Controls:
1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
 2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
 6. Provide with pan leak sensor for automatic unit shut-off.
6. VERTICAL AIR HANDLER, INDOOR FAN COIL UNIT
- A. General
- The PVFY shall be a multiposition indoor fan coil design with a fixed bottom return, a fixed vertical discharge supply, and a modulating linear expansion device. The unit shall have the capability to be mounted in either the vertical or horizontal (left or right) and have the capability to integrate into systems with various types of indoor units connected. The PVFY shall support individual control using M-NET DDC controllers. Units shall have the ability to control supplemental heat or humidifier via a control board connector and a 12 VDC output. Units shall have ability to output fan speed via a relay kit. The PVFY shall be suitable for use in air handling spaces in accordance with Section 18.2 of UL 1995 4th Edition. The PVFY shall be tested in accordance with ANSI/ASHRAE 193 and have less than 2% air leakage at maximum airflow setting.
- B. Indoor Unit.
- The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- C. Unit Cabinet:
1. The cabinet shall be pre-painted, pre-insulated, 22 gauge galvanized steel.
- D. Fan:
1. The indoor unit fan shall be an assembly with a single direct drive fan with a high efficiency DC motor.
 2. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
 3. The indoor unit shall have a ducted air outlet system and ducted return air system.
 4. The fan shall have 3-speeds with the capability to operate between 0.3-0.8 In.W.G. selectable.
- E. Filter:
1. The unit shall have a 1” filter rack with a reusable filter.
- F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The condensate shall be gravity drained from the fan coil.
- G. Controls:
 1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
 2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8 degree F deadband from set point.
 3. Provide with pan leak sensor for automatic unit shut-off.
7. FLOOR-STANDING-EXPOSED or FLOOR-STANDING-CONCEALED, INDOOR FAN COIL UNIT
 - A. General:

The PFFY shall consist of a floor-standing indoor section with and have a modulating linear expansion device. The PFFY shall support individual control using M-NET DDC controllers.
 - B. Indoor Unit

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
 - C. Unit Cabinet, Exposed:
 1. The casing shall have a beige Acrylic paint finish.
 - D. Unit Cabinet, Recessed:
 1. The casing shall have a galvanized sheet metal finish.
 - E. Fan:
 1. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 3. The indoor fan shall consist of two (2) speeds, High and Low.
 - F. Filter:
 1. Return air shall be filtered by means of an easily removable washable filter.
 - G. Coil:
 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.
 3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.
 - H. Controls:
 1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
 2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

3. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 4. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
 5. Provide with pan leak sensor for automatic unit shut-off.
8. CEILING-SUSPENDED, INDOOR FAN COIL UNIT
- A. General:

The PCFY shall be ceiling-suspended indoor unit section and have a modulating linear expansion device. The PCFY shall support individual control using M-NET DDC controllers.
 - B. Indoor Unit

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. The unit shall have an auto-swing function for the horizontal vane. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
 - C. Unit Cabinet:
 1. The casing shall have a white finish.
 - D. Fan:
 1. The indoor unit fan shall be an assembly with two, three, or four Sirocco fan(s) direct driven by a single motor.
 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 3. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High, and Auto fan function.
 - A. Filter:
 1. Return air shall be filtered by means of an easily removable, washable filter.
 - B. Coil:
 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.
 3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.
 - C. Controls:
 1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
 2. Units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output
 3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
 6. Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.
 7. The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the

indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

8. Provide with pan leak sensor for automatic unit shut-off.

F – Controls

a. General:

The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation.

1. Future system capability for integration to Building Management Systems via factory furnished BACnet[®] and LonWorks[®] interface.

b. Electrical Characteristics

1. General:

The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

c. Wiring:

1. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
2. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.
3. Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.
4. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
5. The AE-200 centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.

d. Wiring type:

1. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
2. Network wiring shall be CAT-5 with RJ-45 connection.

e. CITY MULTI Controls Network

The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks[®] or BACnet[®] interfaces.

f. CMCN: Remote Controllers Backlit Simple MA Remote Controller (PAC-YT53CRAU)

The Backlit Simple MA Remote Controller (PAC-YT53CRAU) shall be capable of controlling up to 16 indoor units (defined as 1 group). The Backlit Simple MA Remote Controller shall be compact in size, approximately 3” x 5” and have limited user functionality. The Backlit Simple MA supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple MA Remote Controller shall allow the user to change on/off, mode (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, and fan speed setting and airflow direction. The Backlit Simple MA Remote Controller shall be able to limit the set temperature range from the Backlit Simple MA. The Backlit Simple MA Remote controller shall be

capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple MA Remote Controller shall display a four-digit error code in the event of system abnormality/error.

The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers (PAR-FL32MA-E / PAR-FA32MA-E) or with other Backlit Simple MA Remote Controllers (PAC-YT53CRAU), with up to two remote controllers per group.

The Backlit Simple MA Remote Controller shall require no addressing. The Backlit Simple MA Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB15 connection terminal on the indoor unit. The Simple MA Remote Controller shall require cross-over wiring for grouping across indoor units.

PAC-YT53CRAU (Backlit Simple MA Remote Controller)			
Item	Description	Operation	Display
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit

PAC-YT53CRAU (Backlit Simple MA Remote Controller)			
Item	Description	Operation	Display
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display “test run”).	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group

g. Centralized Controller (Web-enabled)

1. AE-200 Centralized Controller

The AE-200A Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three (3) AE-50A expansion controllers. The AE-200A Centralized Controller shall be approximately 11-5/32” x 7-55/64” x 2-17/32” in size and shall be powered with an integrated 100-240 VAC power supply. The AE-200A Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the AE-200A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the AE-200 Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the AE-200A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the AE-200A Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

AE-200 (Centralized Controller)			
Item	Description	Operation	Display
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group

AE-200 (Centralized Controller)			
Item	Description	Operation	Display
Temperature Setting	Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. *1. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can be scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3. Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4. When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective

AE-200 (Centralized Controller)			
Item	Description	Operation	Display
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
Multiple Language	Other than English, the following language can be chosen. Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese are available.	N/A	Collective
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: “Batch start/stop”, “Batch emergency stop” By pulse: “batch start/stop”, “Enable/disable remote controller” Output: “start/stop”, “error/Normal” *5. Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective

All AE-200A Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three AE-50A expansion controllers for display of up to two hundred (200) indoor units on the main AE-200A interface.

The AE-200A Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.

Standard software functions shall be available so that the building manager can securely log into each AE-200A via the PC’s web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Tenant Billing shall be available but are not included. The Tenant Billing function shall require TG-2000 Integrated System software in conjunction with the Centralized Controllers.

h. AE-50A Expansion Controller

The AE-50A Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the AE-200A Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the AE-200A. Up to three (3) AE-50A expansion controllers can be connected to the AE-200A via a local IP network (and their IP addresses assigned

on the AE-200A) to the AE-200A to allow for up to two hundred (200) indoor units to be monitored and controlled from the AE-200A interface.

The AE-50A expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the AE-200A and configured to display their units on the main controller, the individual indoor units connected to the AE-50A can still be monitored and controlled from the interface of the AE-50. The last command entered will take precedence, whether at the wall controller, the AE-50A or the AE-200A Centralized Controller.

- i. Power Supply (PAC-SC51KUA)
The power supply shall supply 24VDC (TB3) for the AE-200/AE-50/EB-50GU centralized controller and 30VDC (TB2) voltage for the central control transmission.

G System Commissioning

1. The VRF Manufacturer shall oversee and assist the installing contractor with the start up and commissioning of VRF equipment as outlined below. This process will be completed in two phases. Phase one shall cover the Pre-Start-Up inspection process, Phase two will cover the Physical Start-Up & Commissioning of Equipment.
2. All *VRF System Commissioning* activities shall be completed by an employee of the VRF manufacturer whose primary job responsibilities are to provide start up and commissioning of their products; sales staff or in-house support staffs are not permitted to complete this scope of work.
3. A factory certified representative may assist the VRF manufacturer's personnel in the completion of certain elements of work contained within this specification. Activities completed by a Factory Certified Representative shall be supervised onsite by the VRF manufacturer. Certified representatives shall not be used in lieu of the manufacturer's personnel.
4. The installing contractor shall have been certified by the manufacturer to install VRF systems, having attended a minimum 3- day VRF Service & Installation course at an approved training center. A copy of this certificate shall be presented as part of the VRF equipment submittal process
5. The installing contractor shall assist the VRF manufacturer in their completion of the system review and have available a technician with appropriate diagnostic tools, materials and equipment, as required, for the duration of the inspection process. The technician shall be fully licensed and insured to complete necessary duties as directed under the supervision of the VRF manufacturer.
6. Upon completion of the Equipment Start-Up & VRF Commissioning process, the VRF manufacturer shall provide a formal report outlining the status of the system, in electronic format only. Contained within this report shall be copies of all field inspection reports, required action items and status, Manufacturers design software As-Built, equipment model & serial numbers.
7. Completion of the Equipment Start-Up and VRF Commissioning process shall verify that the VRF system has been installed per the Engineer's design intent and complies with the VRF manufacturers engineering and installation specifications related to their equipment.

H. Pre Start-Up Inspection

1. Contractor shall employ the services of the VRF manufacturer to provide a comprehensive field review of the completed VRF system installation, prior to the physical start up and operation of equipment. Upon satisfaction that the system meets the VRF manufacturer's installation requirements and specifications, the

contractor shall be allowed to proceed with the physical start up and operation of equipment.

2. Prior to the pre-start-up inspection, all systems components shall be in a final state of readiness having been fully installed and awaiting inspection.
 3. The installing contractor shall provide the VRF manufacturer a copy of the electronic design file used in the design and engineering process of the system being inspected. This electronic design file shall have been completed on software approved by the specified VRF manufacturer and shall have been updated to reflect as-built conditions.
 4. The installing contractor shall have prepared the refrigeration piping systems per manufactures equipment installation and service manuals. All refrigerant piping systems, upon completion of assembly, shall have been pressurized to a minimum 600 PSI, using dry nitrogen, and held for an uninterrupted 24HR period, with acceptable change due to atmospheric conditions.
 5. Total refrigerant charge of the system shall be recorded and displayed at the outdoor unit by permanent means.
 6. A review of the equipment settings shall be completed, with recommendations provided to improve system performance, if applicable. Physical changes of system settings will be completed by the contractor. Electronic recording of final DIP switches shall be provided as part of the commissioning report.
 7. A comprehensive review and visual inspection shall be completed for each piece of equipment following a detailed check list, specific to the equipment being reviewed. A copy of the inspection report shall be provided as part of the manufacturers close out documentation. Any deficiencies found during the inspection process shall be brought to the attention of the installing contractor for corrective action. Any system components that are not accessible for proper inspection shall be noted as such.
1. Indoor Equipment report shall contain
 - Model & Serial Number
 - Equipment location
 - Equipment Tag/Identification number
 - Network Address & Port Assignment
 - Digital recording of equipment settings
 - Mounting/support method
 - Seismic restraints used
 - Proper service clearance provided
 - Wiring and connection points are correct
 - High voltage reading(s) within acceptable range
 - Low voltage reading(s) within acceptable range
 - Type of Remote Controller used and its location
 - Occupied space temperature sensing location
 - Air temperature readings within acceptable range
 - Condensate pump interlock method
 - Fan E.S.P. setting
 - Air Filter condition
 - Height differential setting in heat mode
 - Noise level acceptable
 - Refrigerant pipe connected and insulated properly
 - Condensate pipe connected and insulated properly
 - Condition of connected ductwork
 - Fresh air connected
 - Humidifier connected and checked
 - Review of air balance report complete
 - Other interlocked systems, i.e. baseboard heat, booster fan etc.

2. Outdoor Air Cooled equipment report shall contain
 - Model & Serial Number
 - Equipment location
 - Equipment Tag/Identification number
 - Network Address & Port Assignment
 - Digital recording of equipment settings
 - Mounting/support method
 - Seismic restraints used
 - High Wind Tethering method
 - Proper service clearance provided
 - Defrost Condensate removal addressed
 - Wiring and connection points are correct
 - High voltage reading(s) within acceptable range
 - Low voltage reading(s) within acceptable range
 - Control Network settings
 - Noise level setting
 - Refrigerant pipe installed and insulated properly
 - Low ambient operation settings

I. Physical Start-Up & Commissioning of Equipment

1. Upon proper equipment start up by the contractor, following the manufacturers guidelines and specifications, an employee of the VRF manufacturer shall complete a review of the system performance and complete the following tasks:
2. Check and confirm all communication addressing of system components.
3. Check and confirm each indoor unit, individually, is properly piped and wired by commanding the indoor unit on, in either heat or cool mode and verifying proper response.
4. This process shall be digitally recorded and included as part of the close out documentation.
5. Electronically record a minimum of one-hour of operational data per refrigeration system.
6. Electronically record selector switch positions on all indoor and outdoor equipment.
7. The VRF manufacturer shall retain the electronically recorded data, collected during the start-up and equipment commissioning process, at a designated location within the US for future reference.

J. Close-Out Information

1. The VRF manufacturer shall issue a System Performance report at the completion of all fieldwork. Contained within this report shall be an overview of the system performance, recommendations, field reports, all electronic data, and as-built design file.

K. Owner Training and Technical Support

1. The VRF manufacturer shall provide the owner's representative a minimum 4-hour VRF Operation and Maintenance training class covering systems installed under this scope of work.
2. Training program is to be provided at the time of owner occupancy.
3. Owner shall provide a suitable location, onsite, to conduct the VRF Operation and Maintenance class.
4. Training material shall be provided to participants in electronic format.
5. Contact your region's Mitsubishi Electric Professional Solutions Manager for information and pricing related to services required under this projects scope of work.

Item 6: Section 2.26 **ROOF MOUNTED ENERGY RECOVERY VENTILATOR WITH GAS HEAT**, delete in its entirety and replace as follows;

2. 26 ROOFTOP ENERGY RECOVERY VEENTILATOR (ERV-1)

A. General

York Energy Recovery Ventilator, or equal,, shall be listed per UL 1995, Heating and Cooling Equipment. Energy transfer ratings of the energy recovery wheel shall be AHRI Certified. Performance shall be as scheduled on plans. Exhaust discharge and outside air intake shall not be located on the same side on roof top units.

B. Energy Recovery Wheel

1. Wheel shall be of the enthalpy type for both sensible and latent heat recovery and be designed to insure laminar flow. Energy transfer ratings must be AHRI Certified to Standard 1060 and bear the AHRI certification symbol for AHRI Air-to-Air Energy Recovery Ventilation Equipment Certification Program based on AHRI 1060. Ratings in accordance with 1060 without certification are not acceptable.
2. Desiccant shall be silica gel for maximum latent energy transfer. Wheel shall be constructed of lightweight polymer media to minimize shaft and bearing loads. Polymer media shall be mounted in a stainless steel rotor for corrosion resistance.
3. Wheel design shall consist of removable segments for ease of service and/or cleaning. Silica gel desiccant shall be permanently bonded to wheel media to retain latent heat capability after cleaning.
 - a. Wheels with sprayed on desiccant coatings are not acceptable.
 - b. Wheels with desiccant applied after wheel formation are not acceptable.
4. Energy recovery device shall transfer moisture entirely in the vapor phase.
5. Energy recovery drive belt material shall be prestretched high strength urethane and shall be factory installed, eliminating the need for field belt tension adjustment.
 - a. Link style belts are not acceptable.

C. Controls, Factory Furnished

1. **BASIC UNIT CONTROLS:** All internal electrical components shall be factory wired for single point power connection except Electric Pre Heat. All electrical components shall be UL Listed, Approved, or Classified where applicable and wired in compliance with the National Electrical Code. Unit will be provided from the factory with a control panel that includes a 24 VAC transformer, terminal strip, and blower / energy wheel contactors.
 - a. Provide contact for remote time clock operation.
2. **STARTUP (Digital Contact Closes)**
 - a. Supply blower starts
 - b. Exhaust blower starts
 - c. Energy wheel is energized
3. **SHUTDOWN (Digital Contact Opens)**
 - a. Exhaust blower is de-energized
 - b. Supply blower is de-energized
 - c. Energy wheel is de-energized
4. **Start-Stop-Jog Economizer**

There are three modes of control strategies available, Temperature, Enthalpy, or

- Enthalpy and Temperature, selectable via a jumper on the circuit board.
5. Temperature Control - The temperature mode of operation incorporates one sensor located in the fresh air intake of the ERV. The start stop jog sequence is activated when the outside air temperature is between 70°F and 40°F. The start stop jog module provides two potentiometers in order to adjust the Low and High temperature range of the start stop jog sequence.
 - 6.. Enthalpy Control - The enthalpy mode of operation incorporates one enthalpy sensor located in the fresh air intake of the ERV. The start stop jog module compares the outdoor enthalpy to a preselected set point. The start stop jog module begins the start\ top jog sequence when the Enthalpy sensor reports 60%.
 7. Enthalpy and Temperature - The combination mode of operation will activate the start-stop jog sequence when the Enthalpy meets the control curve set point and the outside air temperature is between the Low and High temperature set point.
 8. Low Ambient Ki
 - a. When the exhaust temperature in the exhaust air blower compartment is below the low ambient switch set point, the switch will open, deactivating the fresh air blower and closes the optional motorized intake damper. The system will continue to operate in this mode, drawing warm air out of the building to heat up the wheel surface, until the temperature at the exhaust air blower is 16 degrees above the set point. At that time the switch will close activating the fresh air blower and opens the optional motorized intake damper. The switch is preset at 20°F from the factory, but can be easily reset in the field.
 9. Rotation Sensor
 - a. The rotation sensor and circuit board is factory mounted inside the ERV. When the ERV is energized and a signal to start the wheel is present, it then powers the rotation sensor circuitry with 24 volt signal from control transformer. After the initial time delay of approximately 5 seconds from circuit power up, if the sensor fails to provide a signal pulse (no disk rotation) within approximately 5 additional seconds, the alarm relay will activate and latch (until circuit powers down) providing a 5 amp contact closure output on the circuit board and a red light will glow. This would indicate no disk rotation and/or magnet in the system has stopped at the magnetic sensor pickup point. If the pulse (disk rotation) is detected within the approximately 5 second time period, the alarm relay will remain open. No field timing adjustment of any type will be required.
 10. Motorized Outside Air Damper
 - a. The metal frame with damper blades, linkage, pivots and a 24 volt motor are mounted inside the ERV between intake air hood and energy wheel. When the ERV is energized the intake air and exhaust air blower start and damper motor is provided with 24 volt signal to open. The damper motor will take approximately 60 seconds to fully open, during this timing the intake air blower will remain off until the tilt switch (that is attached to damper blade) closes. Once the tilt switch closes it provides signal, thus completing circuit for the intake air blower contactor and starting this motor. If the system shuts down, this optional kit will de-activate the intake air blower, thus closing (spring return) the intake air damper.
 11. Motorized Exhaust Air Damper

- a. The metal frame with damper blades, linkage, pivots and a 24 volt motor are mounted inside the exhaust air hood. When the ERV is energized the intake air and exhaust air blower start and damper motor is provided with 24 volt signal to open. The damper motor will take approximately 60 seconds to fully open, during this timing the exhaust air blower will remain off until the end switch (that is attached to side of damper motor) closes. Once the end switch closes it provides signal, thus completing circuit for the exhaust air blower contactor and starting this motor. If the system shuts down, this will deactivate the exhaust air blower, thus closing (spring return) the exhaust air damper.

12. Dirty Filter Sensor

- a. Sensors measure the pressure drop across the exhaust air filter bank. Provides indication of switch closure (field adjustable set point) when differential pressure across the filter bank has increase to trip when 24 VAC is applied to terminals. This can be picked up by an alarm, BMS, etc. which will be provided by others.

- D. Provide combination motor starters with NEMA 4X control cabinet.
- E. Factory standard finish for ambient exposure above the roof line.
- F. Provide factory startup services.
- G. Provide factory training services.

Item 7: Section **2.27 ENERGY RECOVERY VENTILATORS**, delete in its entirety and replace as follows;

2.27 ROOFTOP PACKAGE UNITS, GAS/ELECTRIC PACKAGE (RTU-1,2 & 3)

A. General:

The unit shall be a packaged factory assembled heating and/or cooling system. The unit shall consist of all factory wiring with a single point power connection, refrigerant piping and charge (R-410A), operating oil charge, single refrigerant circuit (sizes 036–096) or dual refrigerant circuits (sizes 120–840), with a microprocessor based control system. The unit shall, based on project requirements, include all special features necessary to provide fully conditioned ventilation air at neutral conditions to the building.

B. Unit Cabinet:

- 1. Double wall design, constructed of G-90 galvanized steel, bonderized and pre-coated with a polyester pre-coat finish.
 - a. Top cover shall be a minimum of 18-gage sheet metal with 2.0-in. thick, closed cell polyisocyanurate foam R13 insulation with a 24-gage sheet metal interior liner.
 - b. Access panels and doors shall be a minimum of 20-gage sheet metal with 2.0-in. thick, closed cell polyisocyanurate foam insulation with a 24-gage sheet metal interior liner. Access doors shall be equipped with stainless steel hinges and quarter turn, adjustable, draw tight cam-action latches.
 - c. Corner and center posts shall be 16 or 18-gage galvanized steel, insulated
 - d. Base pans shall be 16 or 18-gage galvanized steel. All openings through the base pan shall have upturned flanges at least 0.5 inches in height.
 - e. Base pans shall be insulated with 0.375-in. thick closed cell foam insulation.

- f. Condensate pan double sloped shall be 20-gage stainless steel insulated with closed cell neoprene insulation.
 - g. Base rail shall be double flanged 12-gage galvanized steel or welded closed section structural steel tubing.
 - h. Roof sections shall be sloped for proper drainage.
2. Unit casing shall be capable of withstanding 1000-hour salt spray exposure per ASTM B117.
 3. Unit shall have insulated access doors, hinged for easy access to the controls compartment and all other areas requiring servicing. Each door shall seal against a triple edge co-extruded EPDM gasket to help prevent air and water leakage and for ease and safety during servicing.
Access doors shall include a thermal break.
 4. Interior cabinet surfaces shall be lined with 24 gage galvanized steel.
 5. Unit shall have a factory-installed sloped condensate drain connection fabricated of stainless steel with welded corners and drain connection.
 6. Unit shall be equipped with fittings in frame rails to facilitate overhead rigging.
 7. Filters shall be accessible through a hinged access panel.
 8. The outdoor air opening shall have a factory provided hood with bird screen.
- C. Fans:
1. Indoor Evaporator Fans:
 - a. Direct-drive Plenum fan(s) shall be provided and both axial and radial clearances must be equal to or greater than fan manufacturer's recommendations for full rated fan performance and efficiency.
 - b. Base mounted and external rotor fans with EC motors shall be statically and dynamically balanced at the factory as a single rotating assembly to a quality level of G=2.5 in accordance with DIN ISO 1940-1.
 2. Condenser Fans:
 - a. Fans shall be external rotor direct driven axial fans with a minimum 5-1/2" spun venturi for high efficiency and low noise, with cast profiled blades.
 - b. The fan motor assembly shall be end mounted to a structurally rigid welded finger guard.
 - b. Fans shall discharge air vertically upward and the finger guard shall be powder coated.
 - c. Fans shall be statically and dynamically balanced as an assembly to a quality level of G=6.3 in accordance with DIN ISO 1940-1.
- D. Compressors:
1. A digital compressor shall be available for lead or both refrigeration circuits. A Digital Control Module (DCM) shall be included. The control system shall be capable of unloading the compressor in an unlimited number of steps from 100% capacity down to 10% capacity
 2. Fully hermetic, scroll type compressors with overload protection and short cycle protection with minimum on and off timers.
 3. Compressor shall be installed in an insulated compartment accessible thru hinged access doors, isolated from the treated air stream.

4. Line voltage controls, operating controls, refrigerant circuit access points, refrigerant flow control devices and compressors shall be accessible from a single location behind left and right hinged access doors for ease of service.
 5. Compressors shall be mounted on rubber in shear isolators and refrigerant lines to include reaction torque loops.
 6. Reverse rotation protection shall be provide or all compressors.
 7. Crankcase heaters shall only be activated during compressor off mode.
 8. Five year parts warranty
- E. Coils:
1. Standard evaporator coil shall have enhanced surface aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with brazed tube joints.
 2. Evaporator coils shall be minimum four (4) rows. Optional six (6) row coils shall are available.
 3. Standard condenser coil shall have enhanced surface aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with brazed tube joints.
 4. Coils shall be pressure tested at 650 psig prior to unit assembly; leak tested at 150 psig with a final test at 475 psig.
 5. Optional coil coatings for corrosion protection shall be available.
- F. Refrigerant Components:
1. Unit shall be equipped with single refrigerant circuit (sizes 036–096) or dual refrigerant circuits (sizes 120–840, with each circuit containing:
 - a. Solid core filter drier.
 - b. Field adjustable externally equalized thermostatic expansion valve.
 - c. Minimum load valve (Optional hot gas bypass).
 - d. Service access ports
 2. Unit shall be equipped with VFD-controlled variable condenser fan speed low ambient head pressure control to allow operation down to 35° F.
- G. Filter Section:
Standard filter section shall be supplied with 2-in. thick MERV-8 pleated media filters.
- H. Controls and Safeties:
1. Microprocessor Controls:
 - a. Capacity is modulated by digital compressor unloading on single circuit and by sequencing and digital unloading on dual circuit systems
 - b. Shall include a field-installed space temperature sensor with communication port.
 - c. Shall provide a 5° F temperature difference between cooling and heating set points to meet ASHRAE 90.1, energy standard.
 - d. Shall provide an alarm indicator and an audible alarm signal.
 - e. Shall provide and display a current alarm list and an alarm history list.
 - g. Compressor minimum run time (3 minutes) and minimum off time (5 minutes) shall be provided.
 - h. Shall have service run test capability
 - i. Shall have a service diagnostic mode.
 - j. Unit shall be complete with self-contained low voltage control circuit.
 2. Safeties:

- a. Unit shall incorporate a solid-state compressor lockout which provides optional reset capability at the space thermostat should any of the following safety devices trip and shut off compressor:
 - 1) Compressor lockout protection provided for either internal or external overload.
 - 2) Low-pressure protection.
 - 3) Freeze protection (evaporator coil).
 - 4) High-pressure protection.
 - 5) Loss of charge protection.
 - b. Supply-air sensor shall be located in the unit and shall be used for compressor stage control.
 - c. Unit shall be equipped with a supply fan status switch to protect the system in the event of a fan drive failure.
 - d. Induced draft heating section shall be provided with the following minimum protections:
 - 1) High-temperature limit switch.
 - 2) Differential pressure switch for proof of induced draft.
 - 3) Flame rollout switch.
 - 4) Flame proving controls.
 - 5) Redundant style gas valve.
- I. Motors:
- 1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
 - 2. All condenser fan motors shall be totally enclosed air-over (IP54) with permanently lubricated ball bearings, class F insulation and manual reset overload protection.
 - 3. All indoor fan motors shall meet the minimum efficiency requirements as established by the Energy Policy Act of 1992 (EPACT), effective October 24, 1997.
 - 4. Standard indoor fan motors shall be open drip proof design. Optional totally enclosed fan-cooled motors (non- ECM) are available.
- J. Additional Features:
- 1. Hot Gas Reheat:

A factory-installed hot gas reheat (HGRH) coil shall be available. The HGRH coil shall be available on the lead circuit only or with a second coil for reheat both refrigerant circuits. Units with HGRH will have variable speed low ambient head pressure control. Cycling or modulating HGRH shall be available.
 - 2. Energy Recovery:
 - a. The factory-installed enthalpy wheel shall be certified to meet the requirements of AHRI Standard 1060 and shall be AHRI listed.
 - b. The enthalpy wheel shall be constructed of corrugated synthetic fibrous media with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media.
 - c. The desiccant material shall be molecular sieve, 4 angstrom or smaller.
 - d. The rotor shall be constructed of alternating layer of flat and corrugated media.
 - e. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass.

- f. The wheel frames shall be evenly spaced steel spokes with a galvanized steel outer band and rigid center hub.
 - g. The wheel seals shall be full contact nylon brush type.
 - h. The wheel shall slide out of the cabinet side for service.
 - i. Wheel cassettes shall be constructed of galvanized steel. Cassettes shall have integral purge section.
 - j. The wheel bearings shall be inboard mounted permanently sealed roller bearings or externally flanged bearings.
 - k. The wheel shall be driven by a fractional horsepower AC motor via a multilink drive belt.
 - l. Energy wheel defrost control and air bypass shall be available.
 - J. The wheel motor control by VFD is available as an option for frost control
3. Gas Heating:
- a. Gas heat shall be induced-draft combustion type with energy saving direct spark ignition systems and redundant main gas valves.
 - b. The heat exchanger shall be of the tubular section type constructed of a minimum of 20-gage type 409 stainless steel.
 - c. Burners shall be of the in-shot type constructed of aluminum coated steel.
 - d. All gas piping shall be clearly identified on the unit cabinet.
 - e. Induced-Draft Fans:
 - 1) Shall be direct-driven, single inlet, forward- curved centrifugal type.
 - 2) Shall be statically and dynamically balanced.
 - 3) Shall be made from steel with a corrosion- resistant finish.
 - f. High-corrosion areas such as flue gas collection and exhaust areas shall be lined with corrosion resistant material.
 - g. The unit shall have factory-installed gas heat with:
 - 1) 2-stage heat control.
 - h. Furnace shall be accessed by a tool type latched and hinged service door as required by ANSI.
 - i. Gas furnace efficiency shall be 80% AFUE
 - j. Gas train consists of, but not limited to, redundant gas valves, safety switches, air flow switch, shutoff valves and intermittent electronic spark pilot ignition system. Provide with 2-stage heating and controls. Selected for 4-inch wg. at the gas train inlet . Factory installed.
4. Convenience Outlet:
Shall be factory-installed and internally mounted with an externally accessible 115-v, 15 amp GFCI, female receptacle with hinged cover. The outlet shall require field-supplied 115-v power supply wiring. Factory-wired GFI with a step-down transformer and 15.0 Amp breaker is also available.
5. Dirty Filter Status Switch:
The manual reset filter status switch shall be a pressure differential switch and will indicate a dirty filter. The switch shall be factory installed.
6. Fan Status Switch:
The unit shall be equipped with a field-adjustable differential air pressure switch installed across the filters or supply fan to provide proof of airflow.
7. 4-Inch Filters: MERV-8, 11, or 14 pleated media filters.

8. Full Perimeter Roof Curb provide as indicted.
- K. Factory Controls: damper with actuators, contactors, service switch, high and low refrigerant pressure safety switches, control and power transformers, indoor fan time delay, temperature controllers, compressor unloading; all factory wired. Provide factory remote control thermostat with manual/auto-summer/winter changeover and 24-hour, 7-day time clock.
1. Provide factory installed economizer assembly; return and outside air filter and hood, dampers with actuators, modulating electric control with outdoor and mixed air thermostats/sensors. Automatic changeover from mechanical to economizer cooling, maximum 100% outdoor air.
 2. Dual compressors provide with step capacity control.
 3. Interlock unit operation with duct smoke detector.
 4. Differential Pressure switches, fan and dirty filter indication.
 5. Provide motor dampers complete with control actuators, factory mounted.
 6. Temperature control; discharge and return ductwork (heating and cooling) control sensor to maintain the discharge setpoint air temperature based upon the return air sensor, through a temperature controller. Set points adjustable through the controller mounted within the space.
 - a. Provide a manual FAN-OFF-HEAT-COOL selection switch, interlock unit

Operation as follows;

 - FAN position, unit runs.
 - HEAT position, cooling off, heating gas burner control valve modulates to maintain setpoint; continuous fan operation.
 - COOL position, heating off, refrigerant control valve to modulate to maintain setpoint; continuous fan operation.. Interlock air cooled condensing unit to operate whenever the unit runs.
 - b. Provide a space mounted thermostat for unoccupied nightset back. In the unoccupied mode, as determined by a time clock, the outside air damper shall be fully closed and the return air damper fully open.
- L. Provide complete fan and compressor noise performance data.
- M. Provide premanufactured roof curb to suit the selected unit by the unit manufacturer as indicated
- N. Provide combination motor starters with NEMA 4X control cabinet.
- K. Factory standard finish for ambient exposure above the roof line.
- L. Provide factory startup services.
- N. Provide factory training services..

Item 8: Section **2.30 Electric Wall Heater**, delete in its entirety and replace as follows;

2.30 ELECTRIC DUCT HEATER (EDH-1)

- A. Manufactured by Warren Technology.
 1. Open coil type as schedule.
 2. Units shall be U.L. Listed for zero clearance and meet all applicable requirements of the latest National Electric Code and A.N.S.I. standards.
- B. Heating elements shall be high-grade nickel-chrome. Element temperature shall not exceed 400°F below the melting point of the element allowed when energized with design voltage in still, free air at 75°F ambient.
- C. Heater frames and control boxes shall be constructed of 20 gauge-galvanized steel or heavier. Frames shall be hot dipped galvanized after fabrication if spot welds are used.

- D. Mounting assemblies for the element support insulators shall pass between the insulators permitting free expansion of the insulators under high temperature conditions without cracking or breaking.
- E. Each heater shall have its load divided into equal steps as shown. All necessary controls for recycling shall be provided in heaters of more than 48 amps.
- F. The following features and accessories shall be furnished as an integral part of each unit.
 - 1. Fused disconnect switch.
 - 2. SCR control.
 - 3. Relays, contactors, etc..
 - 4. Air Flow switch.
 - 5. Magnetic contractors.

Item 9: Section **2.31 AUTOMATIC TEMPERTAURE CONTROLS**, delete in its entirety and replace as follows;

2.1 AUTOMATIC TEMPERATURE CONTROLS

A. SCOPE OF WORK

1. The ATC Sub-Contractor shall review and study all HVAC drawings and all mechanical and electrical specifications to familiarize him with all equipment and sequences. ATC Sub-Contractor shall provide all the required quantities and types of devices necessary to completely perform all sequences, whether or not such devices are explicitly shown on the drawings or specified. If any devices are not specified they shall be of the same high quality of specified components.
2. All interlocking, wiring and installation of control devices associated with the equipment to be controlled shall be provided under this Contract.
3. Provide services and manpower necessary for testing of system in coordination with the HVAC Sub-Contractor, TAB Contractor and Owner's representative and in accordance with the acceptance testing plan and functional performance test narratives.
4. All work performed under this section of the specifications shall comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the ATC Sub-Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The ATC Sub-Contractor shall obtain and pay for all necessary construction permits and licenses.

B. SYSTEM DESCRIPTION

1. The controls are for the following systems and equipment are provided by the HVAC sub-contractor and installed by the ATC sub-contractor
 - a. Heat pump systems install factory furnished controls see sections 2.25 VARIABLE REFRIGERENT VOLUME HEAT PUMP SYSTEM, & 2,28 DUCTLESS SPLIT SYSTEM AIR CONDITIONER The variable refrigerant volume heat pump system will have a manufacturer provided control system.

1. The ATC sub-contractor shall provide all required control wiring between fan coil units, condensing units, control panels, etc, per the manufacturer's recommendations and requirements.
 2. The HVAC sub-contractor shall provide the set-up of the VRV system manufacturer provided control system.
- b. Rooftop Energy Recovery Ventilator (ERV-1) install factory furnished controls see section 2.26 ROOFTOP ENERGY RECOVERY VENTILATOR (ERV-1). The unit will have a manufacturer provided control system.
1. The ATC sub-contractor shall provide all required control wiring between fan coil units, condensing units, control panels, etc, per the manufacturer's recommendations and requirements.
 2. The HVAC sub-contractor shall provide the set-up of the ERV system manufacturer provided control system.
- c. Electric duct heater (EDH-1) see section **2.30 ELECTRIC DUCT HEATER**
1. The HVAC sub-contractor shall provide the installation of the electric duct heater (EDH-1) 1.
 2. The ATC sub-contractor shall provide all required control wiring, sail switch, outdoor air sensor and duct mounted thermostat for a complete working system. The electric duct heater; the unit shall not run until airflow is proven thru the airflow switch. Provide with outdoor temperature sensor to activate the unit whenever the outdoor air temperature is below the setpoint of 50deg.F (manually adjustable). A duct mounted thermostat to maintain the units discharge air supply temperature setpoint of 75deg.F (manually adjustable) whenever activated.
- d. Rooftop Package Units (RTU-1,2 & 3) install factory furnished controls see section **2.27 ROOFTOP PACKAGE UNITS, GAS/ELECTRIC PACKAGE**. The unit will have a manufacturer provided control system.
1. The ATC sub-contractor shall provide all required control wiring between the remote control panel & thermostats, sensors, etc, per the manufacturer's recommendations and requirements.
 2. The HVAC sub-contractor shall provide the set-up of the RTU units manufacturer provided control system.

C. WORK BY OTHERS

5. The ATC Sub-Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
6. The Electrical Contractor shall provide:
 - a. All power wiring to motors and to junction boxes in mechanical rooms. All power wiring from the boxes to all control panels and devices, regardless of location, shall be by the ATC Sub-Contractor.
 - b. Furnish smoke detectors by the electrical sub-contractor and wire to the building fire alarm system. HVAC Sub- Contractor to mount

devices. ATC Sub-Contractor to hardwire to unit fan shut down.

D. CODE COMPLIANCE

7. All equipment or wiring used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
8. All wiring shall conform to the National Electrical Code and the Division 26 specifications – whichever is more stringent.
9. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
10. Comply with FCC, Part 68 rules for telephone modems and data sets.

E. SUBMITTALS

11. Submittals shall be in accordance with Section 013300-Submittals.
12. Shop drawings shall include a riser diagram and floor plans depicting locations of all controllers, routers, hubs, workstations, etc. with associated network architecture and wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Wiring diagrams detailing interconnecting devices such as fan starters, freezestats, smoke detectors, relays, etc., shall be provided for each system. Written narratives for all sequences shall be included. A “Bill of Materials” list shall be provided for each system indicating part numbers, descriptions, manufacturer, and quantities of each component utilized.
13. Submittal data shall contain manufacturer's data sheets on all hardware and software products required by the specification and sequences. Damper, and airflow station schedules shall indicate size, type, configuration, capacity, maximum pressure rating, pressure drop, maximum differential pressure shut-off capabilities, and name and location of all equipment served.
14. Submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, trends, alarms and configuration to be furnished with the workstation software. Provide complete information on user programming (commands, sequences, etc.). Information shall be bound or in a three ring binder with an index and tabs.
15. No work may begin on any segment of the project until submittals have been reviewed for conformity with the design intent of the project and approved.

F. SYSTEM STARTUP AND ACCEPTANCE TESTING

16. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system shall be tested against the appropriate sequence of operation. The system shall be functionally tested as part of the Commissioning process. The warranty period shall begin after successful completion of the system test.
17. The ATC Sub-Contractor shall submit their acceptance testing plan, pre-functional performance test forms and narratives, and functional

performance test forms and narratives. Unless a commissioning agent has been contracted the responsibility to facilitate the commissioning process, the ATC Sub-Contractor shall be responsible for coordinating the attendees needed to demonstrate the sequence of operation performance to the Owner. The controls system will not be accepted without the prior acceptance of the submitted documents noted herein.

18. The ATC Sub-Contractor shall test and set in operating condition all equipment and systems. For major equipment such as chillers, boilers, and air handling units, this shall be done in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. Coordinate with all required attendees.
19. The ATC Sub-Contractor shall provide all manpower and engineering services required to assist the HVAC Sub-Contractor and TAB Sub-Contractor in testing, adjusting, and balancing all systems in the building. The ATC Sub-Contractor shall have a trained technician available on request during the balancing of the systems. The ATC Sub-Contractor shall coordinate all requirements to provide a complete air balance with the TAB Sub-Contractor and shall include all labor and materials in his contract.

G. TRAINING

1. On-site training shall also include a minimum of 8 hours of hands-on instruction geared toward the operation and maintenance of the systems. Two weeks prior to training, the necessary lesson plans, training documents, handouts, etc. shall be provided with the curriculum outline, which shall include as a minimum:
 - a. System Overview.
 - b. System Software and Operation.
 - c. System Access.
 - d. Software features overview.
 - e. Changing set points and other attributes.
 - f. Scheduling.
 - g. Editing programmed variables.
 - h. Displaying and editing color graphics.
 - i. Running reports and trending.
 - j. Workstation maintenance.
 - k. Application programming.
 - l. Operational sequences including start-up, shutdown, adjusting and balancing.
 - m. Equipment maintenance.

H. OPERATION AND MAINTENANCE MANUALS

1. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead time and expected frequency of use of each part clearly identified. These manuals

shall be delivered to the Owner's representative within 2 months of the final approved submittals before substantial completion.

2. The preventative maintenance shall include all tasking, frequency, and special instructions required for a proactive preventative maintenance action plan.
3. Following project completion and testing, the ATC Sub-Contractor shall submit "as-built" record drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software both in written form and on CD/DVD.

I. WARRANTY

1. The ATC Sub-Contractor shall warrant the entire system (parts and labor) for 12 months after successful system acceptance testing is accepted by Owner's Representative. Beneficial use by the owner may be an alternative method to begin the warranty period (providing there is a minimum of 12 months left after successful system acceptance testing and system acceptance by Owner's Representative). During the warranty period, the ATC Sub-Contractor shall be responsible for all software and hardware upgrades and revisions during normal workday schedule, and within 48 hours of notification if solution cannot be resolved via the remote or web-site connection, to provide and maintain complete and workable building control systems.

J. HARDWARE INSTALLATION

1. Installation Practices for Wiring
 - n. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
 - o. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run shall include a separate hot, neutral and ground wire. The ground wire shall terminate at the breaker panel ground. This circuit shall not feed any other circuit or device.
 - p. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
 - q. Wires shall be attached to the building proper at regular intervals such that wiring does not droop. Wires shall not be affixed to or supported by pipes, conduit, ducts, etc.
 - r. Conduit in finished areas, shall be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
 - s. Conduit, in non-finished areas where possible, shall be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure. Wires shall be kept a minimum of three (3) inches from all piping.

- t. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
 - u. Wire shall not be allowed to run across telephone equipment areas.
2. Installation Practices for Field Devices
- v. Well-mounted sensors shall include thermal conducting compound within the well to insure good heat transfer to the sensor.
 - w. Actuators shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
 - x. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
 - y. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
 - z. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
 - aa. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building with a shield to prevent distortion of reading due to wind.
3. Enclosures
- bb. For all I/O requiring field interface devices, these devices where practical shall be mounted in field interface panels (FIP). The ATC Sub-Contractor shall provide an enclosure, which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
 - cc. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
 - dd. FIP enclosures shall be of steel construction with baked enamel finish, NEMA 1 rated with hinged doors and keyed locks. The enclosures shall be sized for twenty percent spare mounting space. All locks will be keyed identically.
 - ee. All wiring to and from the FIP shall be to labeled screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited
 - ff. All outside mounted enclosures shall meet the NEMA-4 rating.
 - gg. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.
4. Identification
- hh. Identify all control wires with labeling tape or sleeves using words, letters, and/or numbers that can be exactly cross-referenced with as-built drawings

- ii. All I/O field devices inside FIP's shall be clearly labeled.
- jj. All enclosures (including controllers), all I/O field devices (except space sensors), all control valves and actuators, all routers and other field devices that are not mounted within FIP's shall be identified as follows:
 - 1 Identification shall be with bakelite nameplates. The lettering shall be in white against a black or blue background, be keyed to the as built drawings, and indicate that the device is a control device.

5. Location

- kk. The location of sensors shall be per mechanical and architectural drawings or as required for proper operation. Coordinate with installing contractor to provide appropriate straight upstream and/or downstream runs for accurate readings of mixed temperatures or flows.
- ll. Space humidity, carbon dioxide or temperature sensors shall be mounted away from machinery generating heat, direct light and diffuser air streams.
- mm. Outdoor air temperature sensors shall be mounted on the north building face directly in the outside air. Install outdoor temperature and humidity sensors with solar radiation/precipitation shields to minimize the effects of heat radiated from the building or sunlight and from rain.
- nn. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

K. WIRING, CONDUIT AND CABLE

20. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

- 21. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
- 22. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- 23. Where wiring is required to be installed in conduit, EMT shall be used unless indicated otherwise on the Drawings or as required by Division 26

specifications. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

24. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
25. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JHboxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
26. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management or smoke control systems shall be in conduit.
27. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
28. Ethernet 10/100 Base –T network wiring shall be equivalent to Owner’s premise wiring or, as a minimum, Category 5 cabling.
29. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
30. Only glass fiber is acceptable, no plastic.
31. Fiber optic cable shall only be installed and terminated by an experienced sub- contractor. The ATC contractor shall submit to the Engineer the name of the intended sub-contractor of the fiber optic cable with his submittal documents.

L. SEQUENCE OF OPERATION

1. Variable Refrigerant Volume Heat Pump System
 - a. The variable refrigerant volume heat pump system shall operate on internal controls to modulate the compressors to provide heating or cooling as required. The system operating mode will be determined by the systems central controller either HEATING or COOLING.
 - b. Indoor Units (FCUs)
 1. The indoor units shall be controlled by unit controllers.
 - c. During occupied periods, the indoor units shall operate to maintain the space controller setpoint.
 - d. The space controller setpoint shall be determined by the central control system unless overridden by the occupant at the space controller.
 - e. When a single ducted unit serves multiple spaces, the space temperature sensor in the unit shall control the operation of the unit. When a unit serves

- single space, the space, the space temperature sensor in the space controller shall control the unit.
- f. During unoccupied periods, the indoor units shall operate to maintain the unoccupied setpoint temperature.
 - g. Rooms with multiple indoor units shall have all units controlled from a single controller unless multiple controllers are indicated on the drawings.
2. Ductless Split System Air Conditioners
 - a. Ductless split system air conditioners shall be controlled by the packaged controls.
 - b. The ATC sub-contractor shall provide all control wiring between the indoor and outdoor units and between the thermostat/controller and the system.
 3. Rooftop Energy Recovery Ventilator (ERV-1) & electric duct heater provide with remote ON/OFF/AUTO switch and 24/7 programmable time clock. AUTO interlock with time clock operation. Field locate per engineers direction. Interlock with unit's factory controls see section 2.26 ROOFTOP ENERGY RECOVERY VENTILATOR (ERV-1)
 - a. ERV-1 shall be energized and run continuously during occupied hours as determined by a time clock schedule.
 - b. When ERV-1 is energized:
 1. The supply and exhaust dampers shall be open.
 2. The supply and exhaust fans shall be energized and run continuously.
 3. The electric duct heater (EDH-1) shall be energized by a duct mounted airflow switch and shall stage to maintain 70°F (adjustable) discharge temperature.
 - c. When the ERV-2 discharge air temperature is above the discharge temperature setpoint the electric duct heater (EDH-1) shall be de-energized.
 - d. Enthalpy Wheel
 1. When the outdoor air temperature is between 55 °F and 75 °F (adjustable), the wheel shall be de-energized.
 - e. When ERV-1 is de-energized:
 1. The supply and exhaust fans shall be de-energized.
 2. The supply and exhaust dampers shall be closed.
 3. The enthalpy wheel is de-energized.
 4. Rooftop Package Units (RTU-1, 2 & 3) install factory furnished controls see section 2.27 ROOFTOP PACKAGE UNITS, GAS/ELECTRIC PACKAGE (RTU-1, 2 & 3)
 - a. RTU-1,2 & 3 each shall be independently energized and run continuously during occupied hours as determined by a time clock schedule. Operating mode for each unit is manual selection at the individual unit remote thermostat/panel.
 - b. When RTU-1, 2 & 3 are energized:
 1. The supply and exhaust dampers shall be open.
 2. The supply and exhaust fans shall be energized and run continuously.

3. HEAT mode, manual selection, the gas heater shall be energized to maintain the space setpoint temperature (adjustable)
 3. COOL mode, manual selection, the gas heater shall be energized to maintain the space setpoint temperature (adjustable)
- c. Enthalpy Wheel
1. When the outdoor air temperature is between 55 °F and 75 °F (adjustable), the wheel shall be de-energized.
- d. When RTU-1,2 &3 are de-energized:
1. The supply and exhaust fans shall be de-energized.
 2. The supply and exhaust dampers shall be closed.
 3. The enthalpy wheel is de-energized.