SECTION 230000

HEATING & AIR CONDITIONING

PART 1 - GENERAL

1.1 NOTE

A. The requirements of Section 200000 apply to work performed under this Section.

1.2 SCOPE

A. The Work under this Section of the Specification shall include the furnishing of labor, equipment and materials for the installation of heating, air conditioning and ventilating systems as specified, shown on the Drawings or implied to provide continuous and satisfactory service.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP UNITS WITH ENERGY RECOVERY

A. Provide packaged outdoor air unit(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. Unit(s) furnished and installed shall be air source heat pumps packaged outdoor air unit (s) as scheduled on contract documents and these specifications. Unit(s) shall consist of insulated weather-tight casing with compressor(s), air-cooled condenser coil, condenser fans, evaporator coil, air filters, supply motors and unit controls, energy recovery wheels and supplemental electric heat. Before shipment, each unit(s) shall be leak tested, dehydrated, charged with refrigerant (R-410A) and compressor oil, and factory run tested for proper control operation. The condenser coils must be aluminum fin, mechanically bonded to copper tubing. Direct-drive, vertical discharge condenser fans must be provided with built-in thermal overload protection. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas. Unit(s) shall be dedicated downflow or dedicated, thru curb horizontal airflow as manufactured. Wiring internal to the unit shall be colored and numbered for identification.

C. Cabinet shall be Zinc-coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit’s surface shall be tested 672 hours in a salt spray test in compliance with ASTM B45. Structural members shall be a minimum of 16 gauge with access doors and removable panels of minimum 20 gauge. Panels shall be 2” double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed. Insulation shall be 2” polyisocyanurate Foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness. Cabinet construction shall provide access panels for all parts requiring service.

Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed. Panels shall be water- and air-tight hinged panels with handles shall provide access to filters, heating section; optional ERV and power exhaust fan section, supply air fan section, evaporator coil section, and unit control section. Door hardware shall be oriented to allow the door swing to be reversed. Latches with hold down hooks will be factory installed on hinged access doors.

D. Unit shall include a motor operated outside air damper and optional return air damper assembly constructed of galvanized steel, and air foil blades with rubber edge seals. Damper blades shall be designed to have no more than 4 cfm of leakage per sq. ft of damper area and shall exceed ASHRAE 90.1 requirements. Linkage shall be concealed out of airstream, within the damper frame to reduce pressure and noise. Damper assembly shall be controlled by a spring return two position or fully modulating actuator. Dampers shall not be sized for air velocities exceeding 2000 fpm.

E. Type 304 Stainless steel drain pan sloped in two directions to ensure positive drainage. Pan shall have a minimum depth of 2". Seams exposed to standing water shall be welded liquid tight. Base of pan shall be insulated with 1" thick foam insulation.

F. Provide openings either on side of unit or thru the base for power, control and gas connections. The base of the unit shall have provisions for forklift and crane lifting.

G. Coil will have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas with no material bridging between fins. The coating process will ensure complete coil encapsulation and a uniform dry film thickness from 0.6 – 1.2 mills on all surface areas including fin edges and meet 5b rating cross hatched adhesion per ASTM B3359- 93. Corrosion durability will be confirmed through testing with no less than 5,000 hours salt spray resistance per ASTM B117-90 using scribed aluminum test school coupons.

H. Field wiring access to be provided thru unit base into isolated enclosure with removable cover. Power wiring to be single point connection. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure. Factory wired main power disconnect device, overcurrent and SCCA rated for total unit power connection. Factory installed safety barrier shall isolate all high voltage components, mounted inside electrical compartment, to protect service personnel from incidental contact. Factory wired Phase monitor shall be included as standard. Factory to mount and wire optional120 volt convenience outlet. Field wiring of convenience outlet not acceptable.

I. Factory wired 24 volt control system complete with required transformers and fusing. Main Control Module (MCM) shall prevent simultaneous operation of any modes and shall enable operation in Dehumidification, Cooling, Heating or Economizer mode based on programmed settings for space conditions (CAV units) or outdoor air conditions and discharge air temperature (VAV units). MCM shall accept separate setpoints for Occupied and Unoccupied states. MCM shall control based on dew point design settings for Dehumidification and Economizer modes, and sensible temperature settings for heating and cooling modes. MCM shall have

onboard clock and scheduling function for occupancy. MCM shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure. Factory installed and wired sensors shall monitor Outdoor Air (OA) temperature, humidity and evaporator leaving air temperature. If an Energy Recovery Ventilator (ERV) is chosen, factory installed and wired sensors shall monitor the exhaust ERV leaving air temperature for defrost control. Supply air sensor shall be furnished with unit. Installing contractor shall install remote mounted supply air sensor in supply air duct and field wire to the unit. Space temp and humidity sensor shall be furnished and field wired to unit by the installing contractor. Fully modulating hot-gas reheat shall be enabled in dehumidification mode and cooling mode with modulation controlled by MCM to maintain supply air temperature (VAV) / space temperature (CAV). System controls shall include anti-cycle timing and minimum compressor run/off-times. Systems controls shall be digital, programmable type with access via factory installed and wired touchscreen, or through portable computer connection. All setpoints, unit functions, and status shall be accessible via the touchscreen or portable computer. Factory wired return air / supply air smoke detector(s). All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

J. Indoor fan shall be direct drive plenum fan, factory installed and wired to on-board Variable Frequency Drive and shall be equipped with slide out service access. All fan motors shall be premium efficiency ODP and meet the U.S. Energy Policy Act of 2005/10 (EPACT). All fan motors shall either be permanently lubricated and/ or have internal thermal overload protection. Outdoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

K. The unit(s) may have fully modulating, SCR controlled, electric heat. The primary heating section will include finned tubular heating elements, automatic and manual cut-outs, low voltage controls, air proving switch, maximum 48 amps per circuit and fusing for heaters over 48 amps. Heater shall be internal to unit cabinet and downstream of the evaporator fan. Heater shall be UL or CSA listed and approved and provide single point power connection.

L. Evaporator and hot gas reheat coils shall be constructed of copper tubes mechanically bonded to a configured aluminum plate fin. Coils shall be leak tested at the factory to ensure pressure integrity. The evaporator coil, reheat coil and condenser coil shall be leak tested to 500 psig and pressure tested to 500 psig. The condenser coil shall have a fin designed for ease of cleaning. Evaporator coil shall have four interlaced rows for superior sensible and latent cooling with a maximum of 12 fpi. Reheat coil shall be fully integrated into the supply air and fan system and capable of delivering design supply air temperature. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated a minimum of six inches. Condenser coil shall be provided with factory installed hail guards.

M. Outdoor fans shall be vertical discharge, direct drive fans constructed of glass reinforced polypropylene blades. Fans shall be low-noise and corrosion resistant. Other fan construction is not acceptable. Fans shall be statically balanced.

N. Capacity control for units equipped with digital scroll compressors, or variable speed compressors, shall be accomplished through a 0-10V signal by the MCM to the compressor controls.

O. Compressor(s) shall be digital scroll type compressors. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise. Provide each unit with (2) hermetically sealed refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, liquid line charging port, discharge, suction and liquid line pressure ports, sight glass, thermal expansion valve, 4-way reversing valve, suction line accumulator, and charge compensator. Provide each circuit with automatic reset high and low pressure switches for safety control.

P. Provide, a factory installed power exhaust assembly that shall be designed to ventilate return air to atmosphere. Fan wheel shall be direct drive plenum fan, factory installed and wired to on-board Variable Frequency Drive Other fan construction is not acceptable. Fan mount to be fixed. Exhaust to ventilate through automatic louver located on both sides of unit cabinet.

Q. The rotor media shall be made of aluminum, formed into a honeycomb structure to minimize pressure loss and avoid plugging. Paper, plastic or fibrous media are not acceptable. The rotor media must be coated to resist corrosion. All surfaces must be coated with a non-migrating desiccant layer to insure that adequate latent capacity is provided. The desiccant coating must be firmly bonded to the aluminum surface and will not be dislodged when challenged with high velocity air up to 5000 feet per minute. Products that loose desiccant when served with high velocity air are not acceptable. The cassette must be a slide out design for serviceability. The media shall be cleanable with low temperature steam, hot water or light detergent without degrading the latent recovery. Sensible and latent recovery efficiencies must be clearly documented through a testing program conducted in accordance with ASHRAE Standard 84 and AHRI 1060. The testing must have been conducted by a qualified independent organization. The performance test reports must be provided for engineering review as part of the submittals for this project. The rotor design shall ensure laminar airflow to minimize parasitic pressure loss and to optimize the operating efficiency of the system fans. The pressure loss across the media shall be no greater than the scheduled pressure loss values. The energy wheel shall operate effectively up to 180 degrees F. The rotor media shall be permanent, with an anticipated life of 20 years. It must be tested in accordance with ASTM Standard E-84 and provide smoke and flame spread ratings of less than 25 and 50 as required by NFPA 90A and UL 1995. A copy of the ASTM E-84 test report confirming the method of test and results shall be provided with the submittal. Heat recovery wheels incorporating “throw-away” media and tested to UL900 for Class 2 filters are not acceptable. The wheel manufacturer must have been producing energy recovery wheels for a minimum of ten years. The rotor shall be supplied with perimeter brush seals and face contact seals to minimize air leakage and wheel bypass. The rotor media shall be supported by a structural aluminum hub and aluminum

reinforcing spoke system. The rotor bearings must be greaseable and provide L10 life in excess of 20 years. The cassette framework shall be made of galvanized steel to prevent corrosion. The rotor must be driven by long-life polyurethane/polyester composite link belt system. The rotor/cassette shall be designed so that belt can be removed or serviced without the removal of the bearing. A 3 phase A/C gear motor shall be utilized to accommodate variable speed applications. Where variable speed control is required for frost prevention, it must be accomplished by the use of a factory installed and wired A/C inverter. The variable speed drive system shall allow for a minimum 60:1 turndown ratio.

R. Rooftop units shall be provided 'DDC Ready' with a low voltage terminal strip that will allow the BAS system to control the unit fans, dampers, heating stages, cooling stages, and hot gas reheat. Any Controls, Time Delays, or Safeties that are required as part of the refrigeration system would remain the responsibility of the unit manufacturer.

S. Contractor shall provide factory supplied 14" tall roof curb, 18 gauge perimeter made of zinc coated steel with supply and return air gasketing, insulation, and wood nailer strips. Ship knocked down and provided with instructions for easy assembly. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

T. Packaged rooftop units with energy recovery shall be manufactured by Trane, York, or Valent.

2.2 DEDICATED OUTOOD AIR UNITS

A. Unit(s) furnished and installed shall be packaged outdoor air unit(s) as scheduled on contract documents and described in these specifications. Unit(s) shall be designed for dehumidification, cooling and/or heating of 100% Outdoor Air. For dehumidification and cooling modes the evaporator temperature or supply air dewpoint shall be monitored, reported at unit controller. Compressor controls shall modulate capacity to maintain evaporator leaving set point for dehumidification mode. Hot Gas Bypass shall not be used to control compressor capacity. Compressor Hot Gas Reheat (HGRH) shall be factory installed. To prevent rehydration of evaporator condensate the reheat coil face shall be located a minimum of 6" downstream from the leaving face of the evaporator coil. Heating system shall include modulating controls. Compressor on-off only or primary heating on-off only controls shall not be acceptable control strategies. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas. Cabinet panels shall be 2" double-wall foamed panel with thermal break construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed. Insulation shall be 2" polyurethane foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness. Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Cabinet floor shall be insulated with 2" double-wall foamed panel with thermal break construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed. Insulation shall not be applied to underside of unit base. Cabinet base rails shall be side base rails shall include openings for forklift and/or tie-down and lift access. To protect unit

base from fork damage side rails shall include removable heavy gauge fork pockets. Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping. Cabinet material interior and base rails: shall be G-90 zinc-coated galvanized steel. Material gauge shall be a minimum of 14-gauge for base rails, 16-gauge for structural members and 22-gauge for access doors and cabinet panels. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with both exterior and interior surfaces cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be in compliance with ASTM B117 salt spray testing at a minimum of 672-hour duration. Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service. Cabinet top cover shall be one-piece construction or where seams exist, it shall be double-hemmed and gasket-sealed. Hinged access panels shall be water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, optional ERV and power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Insulated doors shall be constructed to allow the access door to open in either direction or be removed without removal of a hinge. Latches with locking hasp or tool operated closure devices shall be factory installed on all hinged access panels. Drain Pan material shall be Type 304 Stainless steel drain and constructed to slope in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2" and be fully insulated by no less than 1" of R-6.6 insulation. Provide openings on either side of unit or thru the base for power, control, and gas connections. Cabinet shall include optional interior liner constructed of Type 304 stainless steel with sealed seams. Air inlet hood shall be factory installed and shall not require field assembly. Hood shall include 2" thick removable aluminum mesh mist eliminators sized for a velocity not to exceed 500 FPM at maximum unit rated airflow. Service access shall be hinged and held in place with thumb latches that shall not require tools for service access. Unit shall be equipped with a 6" filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.

B. Unit inlet hood shall include 2" thick aluminum mesh removable mist eliminators with hinged access cover. Inlet velocity shall not exceed 500 FPM. Evaporator Inlet shall include a full complement of pleated media air filters. Filters shall be 2" deep MERV 8.

C. Unit shall include a motor operated outdoor air damper constructed of galvanized steel. Damper blades shall be v-groove design with rubber edge seals designed not to exceed a 4 CFM/SQ FT leakage rate exceeding ASHRAE 90.1 damper leakage requirements. Airfoil design Class 1A rated dampers are optional. Damper actuator shall be factory mounted and wired sealed spring return and fully modulating. Dampers air velocity shall not exceed 2000 fpm. Return Air damper shall be of same material, construction, and leakage rate as outdoor air damper. Return air damper actuator shall be factory mounted and wired sealed spring fully modulating and operate based on outdoor air damper feedback signal to properly regulate RA airflow.

D. All units shall have direct drive, scroll type compressors. Circuit one shall have a digital scroll compressor. Motor shall be suction gas-cooled and shall have a

voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors. Each compressor shall have a crankcase heater or equivalent to minimize the amount of liquid refrigerant present in the oil sump during off cycles. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise. Provide each unit with hermetically sealed refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve. Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.

E. Evaporator, Condenser and Hot Gas Reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins. Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG. The condenser coil shall have a fin designed for ease of cleaning. Evaporator coil shall include six rows of cooling interlaced for superior sensible and latent cooling with a maximum of 14 FPI for ease of cleaning. Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated by a minimum of six inches. Condenser coil hail guards shall be factory installed.

F. Outdoor fans shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets. Fans shall be statically and dynamically balanced.

G. Compressor output capacity shall be controlled by the Main Control Module.

H. Indoor fan shall be direct drive plenum fan, factory installed and wired to on-board Variable Frequency Drive and shall be equipped with slide out service access. All fan motors shall be premium efficiency ODP and meet the U.S. Energy Policy Act of 2005/10 (EPACT). All fan motors shall either be permanently lubricated and/ or have internal thermal overload protection. Outdoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position. Provide shafts constructed of solid hot rolled steel, ground and polished, with keyway, and protectively coated with lubricating oil.

I. Completely assembled and factory installed electric heating system shall be fully modulating, SCR controlled and listed for use in roof top handler. The heating section will include open coil heating elements, automatic and manual cut-outs, low voltage controls, air proving switch, maximum 48 amps per circuit and fusing for heaters over 48 amps. Heater shall be UL or CSA listed and approved and provide single point power connection.

J. All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be a listed as touch-safe design. Field wiring access to be provided thru unit base into isolated enclosure with removable cover. Power wiring to be single point connection. Wiring internal to the unit shall be colored and numbered for identification. Unit shall be factory

wired to field wiring terminal block mounted in isolated enclosure. Factory wired main power disconnect and overcurrent device shall be rated for total unit connected power. Unit SCCR rating shall be a minimum of 5kA. Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically. Phase unbalance protection shall be factory set 2%. Over/under/brown out voltage protection shall be +/-10% of nameplate voltage. Provide unit with phase loss/reversal protection. Factory to mount and wire optional120 volt convenience outlet. Field wiring of convenience outlet not acceptable. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

K. Units shall be provided 'DDC Ready' with a low voltage terminal strip that will allow the BAS system to control the unit fans, dampers, heating stages, cooling stages, and hot gas reheat. Any Controls, Time Delays, or Safeties that are required as part of the refrigeration system would remain the responsibility of the unit manufacturer.

L. System Sensors shall include: Factory installed and wired Outdoor Air Temperature, Outdoor Air Humidity and Evaporator Leaving Air Temperature and factory furnished, field installed Discharge Air Temperature. Space Control or Single Zone VAV: Factory shall furnish Space Temperature and Space Humidity sensor for field installation and connection to the unit. Economizer Option includes Return Air Temperature and Humidity sensor. ERV Option includes exhaust air leaving temperature sensor. Powered Exhaust with Economizer includes duct pressure sensor to be field installed.

M. System controls shall include:

1. Anti-cycle timing.
2. Minimum compressor run/off-times.

N. Provide Optional Smoke Detectors to sense (Return Air / Discharge Air / Return and Discharge Air) stream(s) shall be factory installed and wired.

O. Provide a factory installed power exhaust assembly that shall be designed to ventilate return air to atmosphere. Plenum mounted direct drive airfoil design exhaust wheel material shall be heavy gauge aluminum, welded construction and rated for up to Class III speed/pressure performance. Factory install and wire fan motor to on-board Variable Frequency Drive. Belt-drive and/or forward curve plenums fans shall not be used. Exhaust to discharge through gravity dampers located on each side of unit cabinet.

P. The energy recovery cassette shall incorporate a rotary wheel in an insulated cassette frame complete with removable energy transfer media, seals, drive motor and drive belt. Energy recovery wheel performance shall be AHRI 1060 certified and bear the AHRI certified label. Components that are independently tested or "rated in accordance with" shall not be acceptable. Manufacturer membership in AHRI is not an acceptable substitute. Certified components must be listed as active in the AHRI Directory. The energy recovery cassette shall be an Underwriters Laboratory UR recognized component for fire and electrical safety and bear the

UR symbol. Recognized components shall be listed in the UL directory. The energy recovery cassette shall comply with NFPA 90A by virtue of UL standard 1812 and UL900 fire test for determination of flammability and smoke density. The energy recovery cassette shall carry a 5-Year standard warranty on the entire cassette assembly (excluding the motor) from the date of shipment. Motors shall carry the manufacturers standard 18 month warranty from the date of manufacture.

Q. Cassette frame and structural components shall be constructed of G90 galvanized steel for corrosion resistance. Wheel structure shall consist of a welded hub, spoke and continuous rolled rim assembly of stainless steel, and shall be self-supporting without energy transfer segments present. Wheel structure shall be connected to the shaft by means of taper lock bushings. Wheel bearings shall be permanently sealed and selected for a minimum 30 year L-10 life of 400,000 hours. Bearings requiring external grease fittings or periodic maintenance are not acceptable. Standard cassette may be affixed within the cabinet in any orientation without the need for factory modification.

R. Energy transfer media shall be constructed of a durable synthetic lightweight polymer. Media shall be wound continuously with one flat and one structural layer in an ideal parallel plate geometry. Airflow across heat exchanger surface shall remain laminar. Energy transfer media shall not exceed 3” in depth. Energy transfer media shall be suitable for use in corrosive, marine or coastal environments without the need for additional coatings. Sensible only energy transfer media shall be constructed in the same fashion as the enthalpy transfer media with the exception of the desiccant coating process required for enthalpy wheels.

S. Desiccant shall be either silica gel or molecular sieve and permanently bonded to the energy transfer media without the use of binders or adhesives, which may degrade desiccant performance. Desiccants not permanently bonded are not acceptable due to potential delamination or erosion of the desiccant from the energy transfer media. Desiccant shall be non-migrating nor shall it dissolve or deliquesce in the presence of water or high humidity. Energy transfer media shall be capable of repeated washings without significant degradation of the desiccant bond as documented by an independent third party.

T. Wheels 25" in diameter and greater shall be provided with removable energy transfer segments. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.

U. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Seals shall be non contact nylon pile brush seal orientated in a labyrinth style configuration. Diameter Seals shall be fully adjustable and easily accessible. Perimeter seals shall be permanently mounted to the wheel rim and not require adjustment. Seals that mount to the frame are not acceptable.

V. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Three phase motors shall be suitable for use in both standard and inverter rated applications. Wheels 52” and smaller shall use a urethane stretch belt for wheel rim drive without the need for external tensioners.

Wheels 58” and larger shall use a urethane non-stretch belt with integral cord and constant tensioner. Wheel drive system shall not require periodic adjustment.

W. Energy recovery segments shall be cleanable outside of the cabinet with detergent or alkaline coil cleaner and water. Energy transfer segments shall be capable of submersion in a cleaning solution. Submersion shall be capable of restoring latent performance to within AHRI certified performance limits.

X. A mechanical purge shall be available as an optional accessory as to avoid excessive fan power. When required the mechanical purge sector shall be factory installed and field adjustable. Purge settings shall be calculated using AHRI certified data and adjusted per the wheel manufacturers selection software. Purge shall be capable of limiting Exhaust Air Transfer Ratio (EATR) values to 0.4% through proper fan and purge adjustment.

Y. Contractor shall provide factory supplied 14” tall roof curb, 18 gauge perimeter made of zinc coated steel with supply and return air gasketing, insulation, and wood nailer strips. Ship knocked down and provided with instructions for easy assembly. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

Z. Dedicated outdoor air units with energy recovery shall be manufactured by Trane, York, or Valent.

2.3 VARIABLE AIR VOLUME (VAV) BOXES – SERIES FAN POWERED WITH REHEAT

A. Provide where shown and of the capacities indicated on the drawings variable primary air volume, low pressure, pressure independent terminal fan powered units. Units shall be complete with an acoustically lined galvanized steel plenum, pressure independent volume controller, velocity averaging sensor, externally removable air filter at recirculated air inlet, electric reheat coil, and space thermostat.

B. Units shall be factory-assembled and wired, AHRI 880-2011 rated, horizontal fan-powered terminal unit with blower, motor, mixing plenum, and primary air damper contained in a single unit housing

C. Plenum shall be constructed of heavy gauge galvanized steel and lined with thermal-acoustical insulation complying with UL 181 erosion requirements in accordance with ASHRAE Std. 62.1, complying with requirements of ASTM C1071, and having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive, when tested in accordance with ASTM E84. Insulation to be secured with adhesive. Edges exposed to airstream to be coated with NFPA 90A approved sealant.

D. Units primary air damper assembly shall be heavy-gauge, galvanized steel with solid shaft rotating in bearings. Damper shaft shall include a visual position indicator etched into the end of the damper shaft, to clearly indicate damper position over full range of 90 degrees. Low leakage damper assembly with damper blades for tight airflow shutoff incorporating a peripheral gasket. Air leakage past closed damper to be a maximum two percent of unit maximum airflow at 3 inch

w.g. inlet static pressure, tested in accordance with ASHRAE Std 130.

E. Inlet Valve to have consistent diameter, to retain flex duct and provide a stop for hard duct. The gasket seal shall be a low leakage continuous piece with a peripheral gasket for tight airflow shutoff. Include two heavy duty stop pins to accurately position the damper in the closed position.

F. Units shall have single direct drive centrifugal fan with forward curved blades. Fan motors shall be brushless DC controlled by an integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. Permanent magnet type motor with near-zero rotor losses designed for synchronous rotation. Designed to maintain a minimum 70 percent efficiency over the entire operating range.

G. Units shall be pressure independent and capable of resetting air flow between factory preset maximum and minimum as determined by the space thermostat regardless of changes in system air pressure. Devices using CFM limiters will not be acceptable. The controller shall maintain a constant air flow at any set point from minimum to maximum within + or - 5 percent of maximum volume from minimum static pressure to 3 inches SPWG.

H. The velocity averaging sensor located in the terminal inlet shall provide a differential pressure signal to the volume controller so that the sensing accuracy is within + or - 5 percent regardless of inlet air flow conditions and without the requirement of any length of straight duct upstream of the inlet. The accuracy of the sensor shall not be affected by connecting a 90 degree elbow directly to the inlet. Certified test data shall be submitted substantiating the sensor performance.

I. Electric reheat coils shall be open wire 80/20 nickel-chrome elements supported by ceramic insulators in a 20 gauge galvanized steel casing. Integrated control panel to be NEMA 250, type 1 enclosure with have hinged access panel for entry to heater controls and safety devices. Provide single point electric connection with power and control circuit disconnect means. Provide a primary automatic reset thermal cutout and electrical fan interlock to prevent heater operation when fan is not running. Provide non-fused door interlocking disconnect switch. Provide SCR (Silicon Controlled Rectifier) controller. Heater shall be ETL listed to the UL Standard and provided by the terminal unit manufacturer and provided with controls required for full compliance with UL and the National Electrical Code.

J. External differential pressure taps separate from the control pressure taps shall be provided for air flow measurement. Terminals shall have a flow chart attached.

K. Terminals shall be complete with factory furnished and installed electronic controls. Controls shall be compatible with automatic temperature control system provided. Controls furnished with the variable air volume box shall be capable of performing the following functions:

1. Modulating control of heat.
2. Occupied/unoccupied control.
3. Morning warmup.
4. Heating/cooling changeover.

L. Certified sound performance data determined in accordance with ADC Test Code 1062-R4 and ISO 3741 shall be submitted for approval for both discharge and radiated sound at an inlet static pressure of 0.75 inch SPWG for specified air volumes. Discharge sound power levels and radiated sound power levels less a 10 Db allowance for room absorption shall not exceed NC-35 in any octave band re: 10-12 watts. Performance data submitted shall be certified as tested in accordance with ADC Test Code 1062-R4.

M. Units to have single-point power connection and equipment wiring to comply with requirements of NFPA 70.

N. Terminals shall be Trane, Environmental Technologies, or Titus.

2.4 DUCTLESS SPLIT SYSTEM HEAT PUMP - CEILING RECESSED

A. Provide direct expansion, split system heat pump system consisting of exterior unit and interior fan coil unit. Unit shall be ARI rated but shall operate at the conditions and capacities as noted on the drawings.

B. Outdoor condensing unit

1. Outdoor condensing unit shall be air cooled with horizontal air discharge provided with a scroll compressor.
2. Compressor shall be scroll type provided with internal vibration isolation, crank case heater and motor winding over temperature and overcurrent safety devices.
3. Heater transfer coil shall be copper tube with aluminum plate fins. Heat rejection fan shall be deep pitched corrosion resistant propeller fan protected by a fan guard. Fan shall be direct driven by permanently lubricated motor with inherent overload protection and class B insulation.
4. Provide outdoor unit with defrost controls, high and low pressure safety controls, time delay relay to prevent short cycling and automatic restart on resumption of electric service after a power failure. Controls shall be solid state.
5. Casing shall be suitable for exterior use and shall be provided with baked enamel finish over properly treated galvanized steel or other approved corrosion resistant finish.

C. Indoor Unit

1. Provide ceiling recess mounted, fan coil unit with ducted discharge compatible for use with condensing unit specified above.
2. Fan coil unit shall be complete with insulated casing with drain pan, built-in condensate pump, copper tube aluminum fin direct expansion refrigeration coil with suitable expansion valve, distributor and solenoid valve, fan section and filter section and auxiliary electric heat. Evaporator fan shall be direct drive suitable for the installed field conditions and capacity. Provide backwater valve in condensate drain line.

D. Ductless split air-condensing unit shall be Mitsubishi, Carrier, or Sanyo.

2.5 EXHAUST FANS - CENTRIFUGAL ROOF MOUNTED DOWNBLAST – DIRECT DRIVE

A. Provide roof exhaust fans in accordance with the schedule on the drawings and the specifications below.

B. Housing, motor cover, shroud, curb cab, and lower windband shall be constructed of heavy gauge aluminum. Shroud shall have an integral rolled bead for extra strength and be drawn from a disc and direct air downward. Lower windband shall have a formed edge for added strength. Motor cover shall be drawn from a disc. Housing components shall have final thicknesses equal to or greater than preformed thickness. Curb cap shall have pre-punched mounting holes to ensure correct attachment to curb. Drive frame assemblies shall be constructed of heavy gauge steel mounted on double studded true vibration isolators sized to match the weight of each fan to ensure no metal to metal contact.

C. Fan wheel to be constructed of aluminum and to be non-overloading, backward inclined type that has been statically and dynamically balanced. The wheel cone and fan inlet shall be matched to provide maximum operating efficiency.

D. Motor enclosure to be open drop-proof type. Motor to be a DC electronic communication type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Motor to be permanently lubricated heavy duty ball bearing type to match with the fan load and pre-wired to the scheduled voltage and phase. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed. Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VCD signal. Motor shall be a minimum of 85% efficient at all speeds.

E. Disconnect means for single phase motors shall consist of motor starting switch inside of fan housing. Single phase motors smaller than 1/12 horsepower may be inherently overload protected and provided with cord ad plug for disconnect means. Three phase motors shall be provided with three pole disconnect switches, mounted in the fan housing.

F. Roof curb shall be as specified in Section 20 00 00.

G. Provide galvanized steel bird screen to protect fan discharge

H. Provide gravity damper to prevent outside air from entering back into the building when fan is off. Damper shall consist of galvanized frames with pre-punched mounting holes balanced for minimal resistance to flow.

I. Exhaust fans shall be Greenheck, Cook, or Penn.

## 2.6 AIR DEVICES

A. Provide air devices to complete the heating, air conditioning and ventilating systems. Air devices in ceiling shall have flat white lacquered finish unless noted otherwise. Coordinate the appropriate border and mount for the specific application.

B. Air devices shall be as manufactured by Titus, Tuttle & Bailey, Price, Anemostat, Krueger, or Metalaire.

C. Air devices used for relief shall have backdraft dampers installed behind the air device or in the ductwork connected to the device. Damper shall be gravity operated with extruded aluminum frame and blades, metal axles turning in synthetic bearings and have extruded vinyl, polyurethane sponge or neoprene blade seals. Backdraft damper shall be Greenheck model EM, or similar of American Warming and Ventilating, or Ruskin.

D. Supply air registers in the ceiling with square or rectangular necks shall have aluminum adjustable curved vane face bars with opposed blade damper. Registers shall provide four-way distribution, unless indicated otherwise.

1. 250-AA

E. Sidewall supply air registers shall be double deflection with vertical face bars and opposed blade damper. Construction shall be aluminum with white finish.

1. 300FL

F. Sidewall return/exhaust registers (more than 7'-0" above floor) shall be horizontal fixed bar set at 35 degrees or fixed curved bar with opposed blade damper. Register shall be aluminum construction with white finish. Omit damper where indicated as grilles.

1. 350FL

G. Sidewall return registers (below 7'-0" above floor) shall be heavy duty 14 gauge reinforced steel bars set at 1/2 inch centers on 40 degree angle. Provide with opposed blade damper (delete damper where noted as grilles). Finish shall be white enamel.

1. Titus 355RL-HD

H. Ceiling return/exhaust registers shall be extruded aluminum frame and grid with 1/2 inch spacing vertical blade lattice core and provide with opposed blade damper. Delete damper where noted as grilles.

1. Titus 50F

## 2.7 DUCTWORK

A. Provide ductwork and plenums of the sizes shown on the Drawings and the materials, gauges and construction as listed below.

B. Ductwork shall not be fabricated or installed until clearances and dimensions have been verified in the field. Discrepancies between the duct sizes and configurations shown on the Contract Documents and those required to meet field conditions shall be brought to the attention of the Architect for his direction. Ductwork fabricated or installed prior to field verification that the ductwork will fit is done at the Contractor's risk and expense.

C. For details of duct construction not specified below refer to the latest editions of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Manuals. Duct systems shall be defined as follows with the applicable manual.

1. All systems "HVAC Duct Construction Standards" metal and flexible.

D. Ductwork shall be galvanized steel except as specified hereinafter of sizes indicated with sheets shaped and constructed as noted in the SMACNA Manual.

E. Flexible ductwork shall consist of a coated spring steel wire helix, polymeric liner, fiberglass insulation and fiberglass reinforced metallized film vapor barrier. Flexible ductwork shall be listed by Underwriters Laboratories under UL 181 standards as Class I flexible Air Duct Material and shall comply with NFPA Standards 90A and 90B. Flexible duct shall be rated for two inches positive and negative pressure and 2500 fpm maximum velocity. Flexible ducts shall be Thermoflex M-KE, Wiremold or General.

F. Where ducts are noted to be acoustically lined, they shall be lined with one half inch thickness of coated and edge sealed lining system. Liner and insulation shall meet requirements of UL 181 and NFPA 90A/B. Liner shall meet bacteriological standards of ASTM C 1071. Seams and cut edges shall be sealed from airstream using metal brackets. Use of adhesive-backed tape is unacceptable. Insulation shall be 3 lb/cubic foot density with a minimum R-Value of 2.0. Duct sizes shown on drawings are the interior sizes of insulated duct. As a minimum, supply and return ducts from heating, ventilating and air conditioning units, including VAV terminal units, for a distance of fifteen feet from the units shall be acoustically lined. Duct lining shall be Owens Corning QuietR Duct Liner or equal of Johns Manville, Certain Teed or Knauf.

G. Ductwork shall be galvanized steel except as specified hereinafter of sizes indicated with sheets shaped and constructed as noted in the SMACNA Manual and of the pressure classification required to meet the pressures listed in the equipment schedules.

H. Duct connections to air handling units and elsewhere as required to compensate for expansion and contraction and noise reduction shall be made with UL approved glass fabric such as Ventglas as manufactured by Vent Fabrics, Inc.

I. On low pressure systems duct details shall be as follows:

| | | |
|---|---|---|
| 1. | Square elbows | Figure 4-2 |
| 2. | Hangers | Figure 5-1 |
| 3. | Tee connections | Figure 3-6 |
| 4. | Register on trunk | Figure 7-6 |
| 5. | Volume dampers | Figures 7-4 and 7-5 |

J. Provide manual volume dampers as shown on the Drawing and additionally as required to properly balance the air distribution systems as directed by the independent Test and Balance Agency.

## 2.8 LOUVERS & DAMPERS

A. Provide louvers and dampers required for the operation of the mechanical systems as indicated on the drawings. Units shall be fabricated after field measurements have been made.

B. Louvers shall be constructed of 0.081 inch thick type 6063-T5 aluminum alloy with integral caulking slot and retaining bead for installation in masonry openings. Fasteners shall be aluminum or stainless steel. Louvers shall be stationary type with drainable blades in a 4" louver frame. Each stationary blade shall incorporate an integral drain gutter and each jamb shall incorporate an integral downspout so water drains to blade end, then down the downspouts and out at the louver sill rather than cascading from blade to blade. Each louver shall be equipped with a framed, removable, rear-mounted bird screen of 0.75" x 0.051" expanded, flattened aluminum. Each factory assembled louver section shall be designed to withstand wind loadings of 25 PSF (100.0 MPH wind equivalent). The beginning point of water penetration for the louver shall be above 1250 fpm free area velocity. Louver frames, mullions, and section joints shall be adequately supported from the building structure to withstand this same wind loading. Louver performance data shall be licensed under the AMCA Certified Ratings Program and shall bear the AMCA Certified Ratings Seal. This certified performance data shall include air flow pressure loss and water penetration, and shall demonstrate performance equal to or better than the model specified. Louver shall be supplied with a baked enamel finish applied after a thorough cleaning and preparation of the metal surface. A total dry film thickness of approximately 1.2 mm shall be provided. Color to be selected by the Architect from the standard color chart. Louvers shall be Greenheck ESD-403 drainable type, or similar of American Warming and Ventilating, or Construction Specialties.

C. Motor operated damper blades shall be 16 ga galvanized steel 3V type with three longitudinal grooves for reinforcement. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper (blades that are non-symmetrical relative to their axle pivot point or utilize blade stops larger than 0.500 in. are unacceptable). Blade seals shall be TPE. Linkage shall be blade-to-blade concealed in jamb (out of the airstream) to protect linkage and reduce pressure drop and noise. Damper frame shall be 16 ga galvanized steel formed into a structural hat channel shape with reinforced corners to meet 11 ga criteria. Bearings shall be corrosion resistant, permanently lubricated, synthetic (acetal) sleeve type rotating in extruded holes in the damper frame for maximum service. Axles shall be square and positively locked into the damper blade. Jamb seals shall be flexible stainless steel compression type to prevent leakage between blade end and damper frame. The Damper Manufacturer's submittal data shall certify all air leakage and air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3 and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Motor operated dampers shall be Greenheck model VCD-23, or similar of American Warming and Ventilating, or Construction Specialties.

## PART 3 - EXECUTION

### 3.1 INSULATION

A. After the systems have been installed and tested, insulation as specified below shall be applied. Materials shall be Underwriters Laboratory, Inc., approved and

shall be applied as recommended by the manufacturer's written instructions. Materials used shall be the products of Owens Corning, Manville, Knauff Corporation, Armstrong, Certainteed, Miracle Adhesive, Moneco or Benjamin Foster and shall be similar to those products that meet the specifications below.

B. Ductwork

1. Exposed supply ductwork and return air ductwork except where ductwork located in the room supplied and exposed outside air ductwork shall be insulated with a minimum 1-1/2 inch thickness of 3 PCF density, a minimum R-Value of 6.0 for attic/concealed spaces and R 8.0 for exterior use fiberglass board with reinforced foil faced ASJ vapor barrier jacket secured to duct with Graham weld pins or perforated base stick clips set in Moneco M46420 adhesive. Pins shall be covered with finish cap to match insulation. Butt joints and seams and cover with vapor barrier mastic. Finish with a coat of lagging adhesive such as Benjamin Foster 30-35 or Moneco 55-10 embedding 8.5 glass cloth fabric over the adhesive. Use corner beads on edges of the duct.
2. Concealed supply air duct, return air duct, outside air duct, and exhaust duct within apartment units shall be covered with minimum 2 inch thickness of 3/4 PCF density, a minimum R-Value of 6.0 for attic/concealed spaces and R 8.0 for exterior use flexible fiberglass duct covering with reinforced foil and kraft paper vapor barrier FRK jacket. Insulation shall be applied to duct over 100 percent coverage of duct adhesive such as Benjamin Foster 85-20. Edges shall be butted together with a vapor barrier lap of 2 inch minimum. Seal joint and punctures with Benjamin Foster 30-35. Where ducts are over 24 inches in width, weld pins and caps shall be used to secure insulation to underside of duct. Secure laps with adhesive and flared staples on 4 inch center.
3. Ductwork that is internally lined with energy code compliant liner is required to be insulated externally as indicated herein.
4. Ductwork exposed to outdoor elements shall be covered with a minimum 1-1/2 inch thickness of 6 PCF density and minimum R-Value 8.0 rigid fiber board with vapor barrier jacket, applied to duct with stick pins and adhesive. Joints shall be lapped and sealed. Slope insulation to drain by providing insulation blocking underneath of insulation board. Finish with emulsified aluminum paint containing asphalt and glass fiber binder. Finish with 2 coats of lagging weatherproof adhesive imbedded with glass cloth using corner beads on edges. Paint with weatherproof paint suitable for the installation. Top of duct and extending 2 inches down sides of duct shall additionally be covered with 22 gauge galvanized sheet metal cover which shall be sloped for positive drainage.

C. Piping

1. Refrigeration suction piping and condensate drain piping above the ground shall be covered with 1/2 inch thickness of 6 PCF polyethylene foamed closed cell elastomeric pipe covering conforming to Mil Spec 15280, Armstrong Armaflex. Fittings shall be neatly mitered or continuous with piping. Covering on exterior of building shall be finished with 2 coats of Armaflex or other latex base finish to blend with adjacent finishes.
2. On exposed insulated piping in finished areas within seven feet of the floor,

provide .010 inch thick galvanized steel insulation jackets. This does not include piping exposed in unfinished areas such as boiler rooms, storage rooms, etc.

3. On exposed insulated piping exposed to outdoor elements, provide. 016 aluminum insulation jackets.
4. At pipe hangers for piping carrying fluids with temperatures below 70 degrees, provide rigid core of insulation to support the pipe. Rigid insulation shall be the same thickness as the adjacent insulation and shall have the same flame spread and smoke developed ratings.

3.2 TESTING AND BALANCING AIR & WATER SYSTEMS

A. The air distribution system shall be balanced and adjusted to distribute the air quantities as noted on the drawings. Demonstrate to the Architect's satisfaction knowledgeability in this work and familiarity with the test instruments to be used. If the Architect does not approve of the Contractor's qualifications, the Contractor shall engage the services of an independent test organization specializing in this work and is a member of the Associated Air Balance Council or other nationally recognized air balancing organization.

B. Test equipment must be approved by the Architect and properly calibrated prior to starting work. Repairs, alterations, adjustments and readjustments necessary to meet the design conditions shall be made.

C. The balancing agency shall review the drawings before installation and advise the Contractor of additional dampers required in the ductwork, flow devices and balancing valves in the water piping, etc., to effectively and properly balance the systems. These devices shall be installed at no additional cost to the Owner.

D. At the completion of the balancing and adjusting and prior to the operating test, submit to the Architect three (3) certified typewritten reports to be retained by the Architect. Reports shall include:

1. Velocities and air quantities at supply returns and exhaust outlets installed under this contract.
2. Pressure and/or temperature difference across various pieces of equipment.
3. Air temperature delivered from heating and cooling equipment.
4. Water quantities at flow indicators.
5. Schedule of equipment.
6. Speed of belt driven equipment.
7. Nameplate data on motors installed under this contract.
8. Actual operating voltage and ampacity readings on motors.
9. Separate six hour operating tests shall be made during the cooling season and during the heating season in which an hourly record shall be made of the following:
    a. Settings of control equipment.
    b. Outside weather conditions.
    c. Thermostat readings.
    d. Dry and wet bulb temperatures in spaces.

    Outside temperatures shall be below 40 degrees Fahrenheit during

the heating test and above 85 degrees Fahrenheit during the cooling test.

E. The outside air quantity for the variable volume air handling units shall be balanced in the following manner:

1. With the air handling unit operating at maximum air quantity the outside air damper shall be adjusted to the minimum outside air percentage as noted on the drawings. The return air damper shall be adjusted to allow the corresponding return air quantity.
2. With the air handling unit operating at maximum turn down, the outside air damper shall be adjusted to allow the same quantity of outside air (in cubic feet per minute) as allowed in Step 1 above. The return air damper shall be adjusted to allow the corresponding return air quantity.
3. The outside and return air dampers shall modulate between the two points described above.

3.3 AUTOMATIC TEMPERATURE CONTROLS

A. Provide labor, materials, equipment, services, etc., to install a system of automatic temperature controls to perform the functions noted on the drawings. Coordinate with unit supplied controls.

B. System shall be DDC and shall be installed under the supervision of the manufacturer's authorized representative.

C. Power source for the system shall be taken from 120 volt sources. Provide motors, starters, overload protection, control power transformers and related wiring devices, etc., in accordance with the applicable requirements of the Division 26 as appropriate for the voltage used. Interlock wiring to fans, pumps, motors, dampers, valves, etc., shall be provided as part of this work.

D. Automatic dampers shall be furnished by the temperature control manufacturer, but shall be installed by the trade normally installing such item, under the supervision of the control manufacturer.

E. The temperature control system, as hereinafter specified and designated on the drawings and plans, shall be guaranteed free of original defects in material and workmanship for a period of two years. After completion of the installation, thermostats, control valves, control motors, dampers, etc., shall be regulated and adjusted to perform the proper function.

F. Prepare a schematic drawing of the temperature control system and submit them to the Engineer for his review prior to starting work.

G. Upon completion of the work, revise the diagrammatic layouts to record conditions and mount the revised layouts in clear plastic envelopes where directed.

H. Control devices shall be identified by embossed nameplates to identify control devices as shown on control diagram.

I. Dampers shall be Arrow Foil double seal dampers with a maximum 0.5 percent

leakage or Honeywell D642 or D643 Type.

J. Schneider Electric/Invensys IA Series, installed by NRG Controls, Inc. 48 S. Harrisburg Street, 2nd Floor, Harrisburg, PA, 17113. University proprietary system as approved, to tie into the Campus Building Automation System.

END OF SECTION 230000