

SECTION 23 81 33**SEMI-CUSTOMIZED ROOFTOP AIR CONDITIONING UNITS (GAS - ELECTRIC)
(3 TONS AND LARGER)****PART 1 - GENERAL****1.1 RELATED REQUIREMENTS**

- A. Comply with General Requirements in Division 1 - General Requirements, and all referenced documents.
- B. Comply with all other Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other trades as required.

1.2 SYSTEM DESCRIPTION

- A. The work shall include installing new specialty semi-customized electric cooling gas heating roof mounted air conditioning units to meet scheduled capacities and to effect outside air control by modulation and space relative humidity control.
- B. Contractor shall connect all ductwork, condensate drain piping, gas piping, roof curbs, temperature controls, power supply, disconnects, factory furnished field installed accessories, appurtenances, insulation, supports, flashing, etc. to make a complete and operational system.

1.3 QUALITY ASSURANCE

- A. All equipment and materials shall be new and of the best quality complying with all standards specified herein.
- B. All equipment and materials shall be installed in a workmanlike manner by trained and experienced mechanics as recommended by the equipment manufacturer and as detailed on the Drawings.
- C. Units shall be rated in accordance with ARI Standards 210/240 or 360 and 270, as applicable, and be capable of starting and running at ambient outdoor temperatures as high as 115 Deg.F. while operating to meet the maximum load requirement.
- D. Units shall be designed to conform to ASHRAE Standard 15, latest revision.

- E. Units shall be U.L. Tested and Certified in accordance with ANSI Z21.47 Standards as a total package for safety requirements.
- F. Insulation and adhesive shall meet NFPA 90A and B requirements for flame spread and smoke generation.
- G. Each unit shall be American Gas Association (AGA) Certified.
- H. Unit casings shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500 hour salt spray test.
- I. Each individual unit shall be subjected to a completely automatic factory run test on the assembly line. Each unit shall pass this run test, repair as necessary, prior to being allowed to be shipped to the project site.
- J. Unit manufacturer shall establish an inventory parts program with the District to ensure the timely availability of the most common parts requiring repair or replacement. Inventory list shall be determined by mutual agreement with the Owner.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive literature and installation instructions and method for the configuration of equipment proposed, including wiring diagrams, piping connections, ductwork connections, capacities at scheduled conditions, fan capacity curves, accessories furnished, and other descriptive literature necessary to fully evaluate the Submittals for full compliance with these specifications.
- B. Shop Drawings: Submit in accordance with Section 23 05 00.

1.5 PRODUCT HANDLING

- A. Deliver all equipment to the site where it shall be covered and protected. Material not properly protected and stored and which is damaged or defaced during construction shall be replaced at no cost to the Owner.
- B. Storage and protection of materials shall be in accordance with Section 23 05 00.

1.6 INSTALLATION, OPERATION, AND MAINTENANCE BROCHURES

- A. Furnish all installation manuals required by a trained and experienced mechanical technician for proper installation of equipment. Manuals shall be provided with equipment and be attached thereto, or contained therein.

- B. Furnish three (3) complete bound Operating and Maintenance Brochures with spare parts lists, which shall be submitted at "Substantial Completion" with Close-Out documents.
- C. At project close-out, furnish an extended four (4) year compressor and fourteen (14) year heat exchanger warranty certificates to begin at the end of the first year warranty.
- D. The first year Warranty begins at Substantial Completion. Indicate specific model and serial numbers for all items of equipment furnished to be Warranted. Extended warranties cover parts only.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP A/C UNITS

- A. Packaged Rooftop Units shall be factory assembled, tested, piped, internally wired and shipped in one piece complete with an operating charge of refrigerant and oil. Units shall be direct expansion cooling, natural gas heating, with downflow discharge mounted on a full perimeter roof curb. Packages shall be complete with all operating and safety controls. All units shall be factory test run in the cooling and heating modes with the following items being monitored for each individual unit:
 - 1. Amperage for each electrical component.
 - 2. Refrigerant suction and discharge pressures with corresponding ambient temperatures and relative humidity.
 - 3. Gas flow rate to burners.
 - 4. Verify operation of all safeties by simulating condenser fan and evaporator blower failures.
 - 5. Provide all test information along with a wiring diagram and a maintenance and operation manual inside each unit.
- B. Cooling capacities shall be rated in accordance with A.R.I. standards. Capacities scheduled are gross capacities. Net capacities include deductions of fan motor heat. Submittals must show both gross and net capacities.
- C. Unit casings shall be constructed of phosphatized G90 galvanized steel with factory baked acrylic-epoxy paint or bonderized and coated baked enamel finish in beige color on all exposed surfaces. All assembly screws shall be zinc-chromate coated. Unit shall be equipped with factory installed lifting or rigging lugs. Other features shall include:
 - 1. Access to compressors, controls, filters, fan motor and other items needing periodic checking or maintenance shall be through:
 - a. Hinged access panels on units from 3 to 12 tons in size.

- b. Double wall hinged access panels on sizes over 12 tons in size.
2. Blowers shall be made accessible by:
- a. Removable panels on units 3 to 6 tons in size.
 - b. Double wall hinged access panels on units over 6 tons in size.

Air side service access doors shall be fully gasketed with rain break overhangs, and these doors shall have a metal liner to protect insulation. All interior surfaces in contact with the air stream shall have one inch (1") mat-faced fiberglass insulation. All access doors shall be able to be opened **without the use of tools**. The unit casing shall be assembled in such a manner to be waterproof and provide for natural drainage. The unit base shall be watertight and constructed with 14 gauge load bearing members. Cabinet insulation shall meet ASHRAE Standard 62P and shall generally have 1.5 pound density with foil face coating used where exposed to the airstream in the heating section. The unit shall have a factory provided entry way within the cabinet for all wiring to enter from below within the confines of the full perimeter roof curb.

- D. All units shall be provided with direct drive fully hermetic, or semi-hermetic, single or two-stage compressors. Compressors shall be factory rubber-shock mounted for optimum vibration isolation. Provide an oil level sight glass, oil charging valve, and two points of lubrication on semi- hermetic compressors. Provide refrigerant strainers, filter drier, and service gauge connections on the suction, discharge, and liquid lines for all compressors. High strength non-flexing ring type suction and discharge valves shall be provided. Compressor motors shall be suction gas cooled, be provided with a crankcase heater and have a voltage utilization range of plus or minus 10% of name-plate. Two winding thermostats shall be imbedded between the motor windings for semi-hermetic compressors. Scroll compressors shall have only one internal thermal protection device per winding. Any thermal overload in any single winding will be detected and alarm internal to the unit controls. Standard safety controls shall include high and low pressure cutouts, oil pressure cutouts (semi- hermetic compressors only), loss of charge protection, compressor reverse rotation protection (scroll compressors only), freeze protection, line break thermal and current overload protection, and reset relays. System shall have liquid line driers and shall be fully charged with R-410A. All units shall have specific factory installed humidity control features similar to that of the Lennox Energence with hot gas reheat coils to achieve neutral supply air temperatures in the dehumidification mode of operation. All units larger than 7 tons shall have a minimum of 2 compressors without exception. Multiple compressor units shall be furnished with independently mounted circuits. Compressors shall be capable

of operation down to 25 Deg.F. ambient outdoor temperatures. All Units shall have two-stage compressors in the 3 to 5 ton range.

- E. Evaporator coils shall be constructed of seamless copper tubing mechanically bonded to heavy duty aluminum fins.
 - 1. All cooling coils shall have galvanized steel end casings and equalizing type vertical tube distribution with a top suction connection.
 - 2. Cooling coils shall generally have a minimum of 4 rows. Fins shall not exceed 15 fins per inch.
 - 3. Coils shall be equipped with a thermostatically controlled expansion valve. Multi-compressor units shall be circuited with one circuit and one expansion valve per compressor.
 - 4. Multiple circuits shall be intertwined in the evaporator coil. Single evaporator coils may be either the full face active design or be the face split design.
 - 5. Each unit shall be equipped with a 5 minute anti-short cycle delay timer, or equivalent control strategy used for compressor protection, for each compressor.
 - 6. Coils shall be factory pressure and leak tested at 300 PSIG.
- F. Provide sloped condensate drain pans. Pans shall be sloped in two directions for positive drainage to meet ASHRAE Standard 62. Pans shall be fabricated with Type 304 stainless steel, be minimum 18 gauge in thickness and shall have all welded joints. Alternately, condensate pans can be made of a heavy duty plenum rated plastic material.
- G. Condensing coils shall be fabricated of seamless copper tubing with configured aluminum fins mechanically bonded to tubing. Condenser coil shall be designed for a minimum of 10 degrees F. sub-cooling. Coils shall be factory tested to 450 PSIG air pressure and then vacuum dehydrated. Provide condenser fin hail and vandal guards. Guards shall be made of hot dip galvanized steel; or UV inhibited, PVC coated steel; or factory enamel or epoxy painted steel; or other approved corrosion resistant material. Flat expanded metal, field made devices, and screen or fencing materials are not acceptable.
- H. Outdoor condenser fans shall be vertical discharge, direct drive type, propeller fans. Fans shall have aluminum or steel blades and zinc plated steel hubs which shall be statically and dynamically balanced. Motors shall have permanently lubricated ball bearings, built in current and automatic reset thermal overload protection and weather-tight slingers over bearings. Provide a corrosion resistant metal, or PVC coated steel, fan guard. Units shall have ECM motor condenser fans.

- I. All supply air fans shall be either direct drive, double inlet, forward curve fans with multi-speed (5 speed or ECM) or belt driven, double inlet, forward curve fans with adjustable sheaves. Fan motors 1 HP and larger shall be the premium efficiency type, that are furnished as a standard option by the unit manufacturer. Refer to Specification Section 23 05 13 for general requirements on these motors. Where non-standard motor frames, under 5 HP in size, are the standard motor offered by the unit manufacturer and where these motors are exempt from meeting the EPACT requirements, these motors are not required to be the premium efficiency type. Motors shall have permanent lubricated bearings. Fans shall be statically and dynamically balanced. Fan bearings shall be self-aligning, grease lubricated, ball or roller bearings, of the pillow block type with 200,000 hour bearing design, easily accessed for servicing. Fan wheels shall be constructed of aluminum or steel and be coated with a corrosion resistant finish. Provide optional/alternate motor and drive assembly to produce the design CFM and external static pressure scheduled where required based on scheduled requirements.
- J. Outside air shall be controlled by an optimized dry-bulb type economizer with multi-stage integrated economizer and compressor operation for optimum benefit:
 1. The economizer shall consist of motor operated fully modulating type outdoor and return air dampers, both sequenced and fully adjustable, constructed from low leakage dampers that utilize metal blades with rubber edge seals and aluminum or stainless steel end seals. Damper blades shall be gear driven and be designed to have no more than 25 CFM of leakage per square foot of damper area when subjected to 2" W.G. air pressure differential across the damper, or less than 2% at a total static pressure of 0.5 Inches W.G., with a negative return air static pressure of 0.05 Inches W.G.
 2. Damper motors shall be the spring return type to insure the tight closing of the outdoor air damper during periods of unit shut down or power failure. The outside air damper and actuator shall be capable of opening to a pre-set minimum when the unit is operated in the normal occupied mode. Provide a field adjustable end switch, or equivalent control feature such as a potentiometer or SCR, to allow minimum outside air adjustment to that as scheduled.
 3. A pressure relief damper sized for 100% relief air shall be provided as part of the economizer.
 4. The economizer shall be completely factory installed, wired and run tested.
 5. For units 10 tons in capacity and larger furnish a powered exhaust relief as a part of the economizer package.
 6. Damper actuators shall be compatible with standard 0-10 Vdc Energy Management System output signal to allow modulating control of the minimum outside air flow rate for return air carbon dioxide level control, whether utilized or not. Actuators shall be a "Belimo MFT" type actuator.
 7. Provide weather protected hoods over each outside air intake and relief air outlet. Provide protection from birds on all hoods, using galvanized steel bird screen (1/2" x 1/2" wire mesh) or other approved method.

K. Heating Section:

1. Induced draft power combustion type with energy saving electronic direct spark ignition system and induced draft direct drive centrifugal blower with an electric differential pressure switch to lock out the gas valve until the combustion chamber is purged and combustion air flow is established. Induced draft combustion motor shall have permanently sealed bearings and inherent automatic-reset thermal overload protection.
 2. Heat exchanger shall be of the tubular section type constructed of a heavy gauge Type 409 or 316 stainless steel for enhanced corrosion resistance.
 3. Burners shall be of the in-shot type designed to use natural gas and be equipped with a gas valve and combustion blower. Two to four stage type gas furnaces shall have redundant dual gas valves. Heating control shall be initiated by a 0-10 Vdc signal from a DDC Control System or other signal compatible with the Energy Management System provided and the control sequences specified elsewhere herein.
 4. All gas piping shall enter the unit cabinet at a single location.
 5. Provide flue up discharge deflector where an option exists with the manufacturer.
 6. Unit tubular Type 409 stainless steel gas heat exchangers shall carry a 15-year non pro-rated warranty starting at "Substantial Completion".
 7. Furnace section shall have foil faced insulation on the air side of the casing.
 8. Heating section controls shall also consist of a redundant main gas valve, associated time delay relays, limit switches, centrifugal switch, high temperature limit switch, flame rollout switch and flame proving controls.
- L. Furnish two inch (2") filter racks with two inch (2") thick pleated media filters shipped with the unit, 30% efficient, equal to Camm-Farr 30/30 filters. Both return and outside air shall be filtered by the same filter bank. Filters shall be provided in a large enough quantity to limit the actual face velocity to no more than 375 feet per minute. Filters shall be one standard commercially available size. Filters shall be accessible without the use of tools. All replacement filters shall be as specified in Specification Section 23 30 00. All filter racks shall be provided with accordion type spacers and gaskets to minimize the potential for any bypass air around the filter rack.
- M. Roof curb shall generally be supplied by the same supplier as unit. Alternately, a custom curb manufacturer meeting the specified requirements shall be used if the equipment manufacturer cannot comply with the specified requirements. Dimensions shall be provided to allow for easy duct location and connection to roof curb prior to unit placement. Curb design shall comply with National Roofing Contractors Association (NRCA) requirements. This, typically, requires a curb extending a minimum of eight inches (8") above the top surface of the roof which results in a minimum 18" tall curb. Curbs shall be made from minimum 18 gauge G-90 galvanized steel, have a treated 2" x 4" wood nailer, have hinged corners and be pitched to match the roof slope, from 1/4" to 12", such that the curb top and unit sit level. Custom

adapter curbs shall be used for all units, except where noted on the drawings. These adaptor curbs shall be minimum height required to have no greater than a 45 degree offset to existing curb and be constructed of minimum 18 gauge G-90 galvanized steel. Custom adapter curbs shall be fully welded with no seams and fully sloped so that there are no flat portions of the curb in the horizontal (Refer to Drawings for curb type). Curbs shall be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curbs shall provide for the full support for both the supply and return air ducts. For custom adapter curbs provide shop fabricated curb sized for existing curb dimensions. Provide for a separate thru utility vertical entry point within the footprint of the inside of the curb; no penetrations allowed in the side (vertical portions) of curbs. Curbs shall be fully perimeter insulated with minimum one inch (1") thick neoprene coated rigid fiberglass insulation, minimum 1.5 pcf density, either factory or field insulated.

- N. Units shall have a factory installed and wired non-fused disconnect switch or HACR/fused disconnect switch as scheduled on the drawings. All disconnect switches shall be provided by unit manufacturer, unless specifically noted otherwise on drawings. Additionally, provide a non-powered weatherproof 10 amp capacity, 115 volt, GFCI, duplex service receptacle inside the control compartment, or on the exterior of the cabinet, for each unit where shown on the Drawings. Receptacle power supply shall be from separate 115 volt circuit.
- O. All roof top A/C Units shall have minimum ARI, EER or SEER and furnace AFUE efficiencies as scheduled, each of which shall meet or exceed that required by the 2018 International Energy Conservation Code. All rooftop air conditioning units five (5) tons and less in capacity shall be a minimum 15 SEER efficiency.
- P. Factory mount and wire terminal equipment controllers furnished under this section. Operating controls shall include the following:
 - 1. Each unit shall have a minimum of two (2) stages of heating and cooling on all units over 7 tons in size. For units 7 tons and smaller, single stage heaters shall be suitable.
 - 2. Provide a Conventional Thermostat Interface (CTI) with wiring terminals provided by the unit manufacturer to allow for the interface and control of the number of stages of heating and cooling and the supply fan.
 - 3. Integrated controls shall be furnished by the equipment manufacturer on the unit at the factory under this Section of the Specifications. Controls shall be suitable for field wiring of other temperature control related sensors and accessories in the future.
 - 4. Each cooling system shall also incorporate a dehumidification and refrigerant cycle reheat capability to control space relative humidity to no higher than 60% R.H., adjustable. Sensible cooling shall take priority over the dehumidification mode, and this shall be determined internal to the unit, via, an external 0-10 VDC control

signal which shall equate to the space relative humidity level. At the option of the Energy Management System supplier, this can be emulated through the local unit controller. Fully coordinate the method used with all trades involved.

5. The integrated gas controller (IGC) diagnostics board shall include gas heat operation fault notification using a LED (light-emitting diode). Each unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch, or three continuous short cycles on the high temperature limit switch. Fault indication shall be made using an LED. The IGC board shall contain algorithms that modify evaporator fan operation to prevent future cycling on high temperature limit switch. LED display shall be visible without removal of control box access panel.
- Q. All refrigeration systems shall use an EPA approved refrigerant that will be readily available in the commercial market for the next 10 years under current legislation and protocols. R-410A is the preferred refrigerant to be used. All units furnished on a project shall all utilize the same refrigerant.
- R. Unit electrical connections shall consist of suitable openings in the cabinet for routing of all utility connections within the roof curb to include through-the-bottom power supply connection. The base unit shall contain a low voltage terminal strip in the control compartment to allow for terminal-to-terminal connection of room thermostat (temperature sensor) and field installed accessories. Electrical controls shall be complete with self-contained low voltage control circuit protected by an automatic reset device. All unit power wiring shall enter the cabinet at a single factory pre-drilled location designed for single point electrical service. Unit voltages shall be as scheduled on the Drawings.
- S. Provide the following additional spare parts for entire order at that facility:
1. One additional main unit control board.
 2. One additional unit mounted disconnect for 4 ton unit size.
 3. One additional 4 ton compressor.
- T. Units shall be as manufactured by:
1. Trane with humidity control units.
 2. Lennox with humidity control units.

2.2 TEMPERATURE CONTROL

- A. Under Specification Section 23 09 00, Controls and Instrumentation, space temperature, and relative humidity, as applicable, shall be provided for field installation along with factory mounted and wired terminal unit controllers to control units. Only designated units will have carbon dioxide sensor control.

- B. Each rooftop A/C unit shall have wiring terminals, low voltage terminal strip, to receive signals from the Terminal Unit controller to receive CTI, PWM, 4-20 ma, or 0-10 volt D.C. signals, as applicable, signals to stage on and off heat, energize compressor(s), hot gas reheat sequence, as applicable, control the economizer cycle, and modulation of the outside and return air damper. Provide contacts to energize and de-energize the unit.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

- A. Deliver all equipment to each site. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt.
- B. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost.
- C. During construction, take all steps necessary to protect equipment from damage or vandalism. All damage or vandalism shall be repaired at no cost to the Owner.

3.2 ROOFTOP A/C UNITS

- A. Install manufactured roof curbs on the roof square and level to receive the units. Provide and install additional steel framing as required to provide safe, noiseless, operating systems. Locate units with condensate drain pans sloped for positive pan drainage.
- B. Coordinate the electrical services and control wiring with the Electrical Systems Installer. Coordinate the condensate drainage and gas supply piping systems with the Plumbing Systems Installer. The manufacturer of each item of equipment shall provide complete wiring diagrams to the Electrical Systems Installer and shall provide drawings indicating all required external wiring, piping and arrangement of all field connections.
- C. Coordinate the exact unit locations with the structural systems and the ceiling systems below as actually installed. Shim roof curbs, or adjust as applicable, to make entire top of each curb level.
- D. Make all sheet metal supply and return duct connections with flexible duct connections below the roof.
- E. Install sound and vibration isolation devices as detailed on the Drawings. Install continuous 2" wide by 3/8" thick neoprene isolation strip along the full perimeter of the roof curb for a complete air seal.

- F. Provide for one (1) additional set of fan sheaves for each belt drive unit, as required by the Testing and Balancing Firm, to obtain design air flows. For bidding purposes provide one (1) set of sheaves and belts where required, as follows:

# of Units	Minimum # Sets of Belts & Sheaves
1 - 5	3
6 - 10	5
11 - 15	7
16 - 20	9
21 - 30	14
31 or more	33%

- G. Gas furnaces shall be jumpered to operate at full fire, with the supply fan operating, for a minimum of thirty (30), but not more than sixty (60), minutes to burn off dust, lint, and factory produced oil films. Remove jumper after this process is completed. Perform this work in such a fashion as not to void equipment warranties. Documented factory run tests conducted for 30 minutes will be considered, but must be approved by the Engineer.
- H. At start-up, have all units served by a gas pressure regulator, external to the units, operated at full fire, and adjust gas supply pressure to these units to be between 7-10 inches W.G. Document in writing actual pressure measured going into unit, as well as manifold pressure. Include this information in Start-up Report to be submitted with Close-Out Documents.
- I. Verify all items internal to unit controlled by the terminal equipment controller functions when commanded to operate. Verify that all dampers fully modulate and that they close fully when commanded to be in that position.
- J. Do not operate units without specified air filters being installed. Failure to do so will result in the Contractor cleaning coils at no cost to the Owner.
- K. Tighten and align fan belts and lubricate all bearings. Verify proper rotation of moving parts.
- L. Install all field installed accessories.
- M. Make all power and control wiring connections.
- N. Verify correct operation of equipment, accessories, and control devices.

3.3 CLEANUP

- A. Clean evaporator and condenser coils, condensate pans and condensate drain piping after installation of rooftop A/C units is complete. Clean all debris from inside rooftop A/C unit casings.
- B. Replace air filters with new type and when indicated as indicated in Specification Section 23 30 00.

3.4 OPERATING PROCEDURES AND REQUIREMENTS

- A. Operating and service instructions in illustrated and bound form shall be furnished by the manufacturer, three (3) copies, at "Substantial Completion".
- B. At startup, the equipment manufacturer shall furnish skilled personnel, separate from the installing contractor's work force, to supervise, check out performance, make any required adjustments, place all units in service, and instruct the Owner's personnel for a full period of two (2) hours for each 15 units provided. Fill out a manufacturers start-up report, to be typewritten, for each new unit installed which shall reflect the operating conditions of the electrical power supply, refrigeration system and gas furnace.

3.5 WARRANTY

- A. Transfer Full Parts and Labor Warranty to Owner for a full one (1) year period beginning at "Substantial Completion".
- B. Transfer any and all other warranties as applicable over to the Owner at "Substantial Completion", including extended 4-year compressor warranties, as applicable, on refrigeration equipment and extended 14-year warranties on stainless steel heat exchangers, as applicable.

END OF SECTION