

SECTION 230000

HEATING, VENTILATING AND AIR CONDITIONING

1.1 GENERAL

- A. All work of this Section shall be governed by the requirements of the Conditions of the Contract and the entire Division 1, General Requirements.
- B. Due to the nature of the work and the rigid time schedule required, the utmost cooperation between Contractors must be attained.
- C. Refer to Section 235000 for Supplementary Conditions for Mechanical and Electrical Work, the requirements of which are part of this work.
- D. HC shall visit site to ascertain existing conditions, access available and to take measurements for items related to work.
- E. HC shall provide concrete pads for all plumbing equipment.
- F. HC shall be a firm regularly engaged in the installation of Plumbing systems for a period of at least five (5) years and shall have the licenses and certificates required by local regulations. License/certificate holder shall be an Owner or Officer in the firm and have a minimum of five (5) years employment.
- G. All electrical components shall bear U.L. labels.
- H. HC shall obtain all permits and pay all fees related to his work.
- I. All work shall be in accord with International Mechanical and International Fuel Gas Codes, local codes and regulations.
- J. HC shall provide Owner with invoices and other data required for utility rebate.
- K. HC shall become familiar with drawings of other trades and its impact/effect on the HVAC work.
- L. HC shall fire-stop openings around pipes and ducts passing through floors and walls.
- M. Refer to Section 235000 for coordination drawing requirements.
- N. The following abbreviations shall apply:
 - GC - General Contractor
 - PC - Plumbing Contractor or Sub-Contractor
 - HC - Heating Contractor or Sub-Contractor
 - EC - Electrical Contractor or Sub-Contractor

1.2 QUALITY ASSURANCE

- A. Requirements given herein may be affected by other related requirements of the project specifications. Correlation of contract requirements is the responsibility of the Contractor.

- B. All Heating, Ventilating and Air Conditioning Work on this project shall be governed by this specification.

1.3 SCOPE OF WORK

- A. HC shall provide all labor, material and appliances required for a complete heating, ventilating and air conditioning installation as shown on Drawings and hereinafter specified, including but not limited to the following principal items:

1. Removals and Relocations
2. Piping, Fittings
3. Sheet Metal Work
4. Insulation and Covering
5. Foundations, Supports, Sleeves and Plates
6. Condensing Unit
7. Gas Furnace
8. Exhaust Fans
9. Diffusers, Registers and Grilles
10. Electric Motors, Motor Controllers and Wiring
11. Vibration Isolators
12. Shop Drawings
13. Start-up, Tests and Adjustments
14. Maintenance and Guarantee
15. Guarantee

1.4 WORK IN CONNECTION WITH OTHER TRADES

- A. The following principal items of work will be done under other Sections of these Specifications:
1. Temperature Control Wiring: HC shall furnish all control components and wiring. Controls shall be wired in accord with wiring diagrams prepared by the Temperature Control Manufacturer.
 2. Electric Wiring: HC shall furnish motor starters, controls and other electrical equipment as specified and deliver same to EC at job site for installation. EC shall provide all disconnect switches, fuses and wiring. All equipment, trim and controls furnished by others required to be mounted by HC shall be furnished to him for mounting.
 3. Responsibility: HC shall be held responsible for correct installation and operating of all material furnished by him under this contract whether or not equipment is installed by him.

1.5 REMOVALS AND RELOCATIONS

- A. Refer to section 235000.

1.6 PIPING, FITTINGS

- A. Piping:
1. Refrigerant Piping: Type ACR copper tubing with wrought copper fittings and brazed joints.
 2. Condensate Piping: Schedule 40 PVC.

B. Fittings:

1. All fittings for copper tube shall be wrought copper joined with Silverbrite lead-free solder. Unions of brass pattern shall be used as required to facilitate the removal of equipment or accessories in connection with copper tube. Flanges shall be used on connections greater than 2".

1.7 SHEET METAL WORK

- A. Provide all sheet metal work for all systems shown on Drawings, including all required register boxes, diffuser collars, balancing dampers, fire dampers, and auxiliary work necessary to make the various system complete and ready for satisfactory operations.
- B. Except as noted, all sheet metal for systems shall be fabricated of galvanized steel. Galvanized sheet metal shall be of the best grade. Ducts shall be constructed, braced and reinforced and of a gauge thickness in accordance with SMACNA Duct Manual, latest Edition.
- C. Any duct connections made with holes or open corners shall be opened and redone or soldered tight at the discretion of the Architect. No caulking compound shall be used to cover imperfect workmanship. Panels shall be cross creased for stiffness and supported with braces, ties and angles to prevent buckling.
- D. Double radius turning vanes shall be provided in all square elbows.
- E. Immediately after fabrication open ends of ducts shall be sealed with plastic film to prevent entry of dust and dirt during shipment, storage and installation.
- F. Open ends of existing ducts being extended, altered or cleaned shall be sealed with plastic film to prevent entry of dust and dirt during construction. Plastic film shall also be installed to protect temporary openings in ducts being cleaned.
- G. Acoustic Lining: As a minimum the first 15'-0" of air conditioning supply and return ductwork shall be acoustically lined, 1" thick, heavy duty 3 lbs., density liner tacked and pasted. Also see drawings for addition requirements. Lining shall meet NFPA and NBFU No. 90A Standards for Low Fire and Smoke Spread. Allow for thickness of insulation in duct sizing. Liner shall be fiber free by Owens-Corning, duct liner.
- H. Adhere liner to all interior sides of duct with minimum 50% coverage of a suitable fire resistive adhesive. Use mechanical fastening of Gripnails, Weld Pins, Tuff-Weld Nylon hangers or Stic-Klips on maximum 16" centers at top sections (when width exceeds 12") and on sides (where height exceeds 24"). Butter and point all joints with a fire resistive coating to keep moving air from getting behind the insulation. Use mechanical fasteners on all sides, top and bottom of duct. Coat cap of fasteners and all cut edges of liner with a brush coat of fire resistive coating. Use metal corners to protect leading edges of liner insulation. Skylight exhaust ductwork to be fully lined.
- I. Flexible ductwork shall be insulated, UL181 listed Class 1, length of runs shall not exceed 4'-0", and runs shall not pass-through walls or partitions. Connections to rigid ductwork and diffusers shall be double banded. Thermaflex flex flow elbows shall be provided at all diffuser connections. Flexible ductwork shall not be used for return or exhaust service.

- J. Access doors shall be provided in all casings and ductwork for access to coils, and filters, dampers, fresh air intakes and all other such equipment and locations requiring maintenance or periodic inspection. Where doors are installed in insulated casings, or ducts, these doors shall be double thick steel with an insulated core. Access doors shall have continuous piano hinges and slide bar bolt locks with gasketed edges. Furnish ceilings and wall access doors for access to heating and ventilating equipment as specified.

1.8 INSULATION AND COVERING

A. General:

1. Insulate all cold-water make-up piping, ductwork and equipment as herein noted.
2. All insulation work shall be performed under this Section.
3. All joints shall be butted firmly together. All insulation shall be installed in accordance with best practice of the trade and in accordance with manufacturer's recommendations. All workmanship shall be done so as to leave a smooth finish with no raveled edges.
4. Fittings shall be insulated with preformed sections and covered with Zeston fittings.
5. Insulation shall be continuous at hangers and supports.
6. Provide high density insulation inserts under pipe supports and hangers. For pipes 2" and above, shields to be T-2000 Calsil with ASJ jacket by Thermal Pipe Shields.
7. For all piping, end joint strips and overlap seams shall be adhered with a vapor barrier mastic and stapled with outward clinch staples on 4" centers.
8. All insulation materials, adhesives, mastics and jackets assemblies shall be UL rated and classified. Ratings shall not exceed:

Flame	25
Fuel Contributed	50
Smoke Developed	50

B. Refrigerant Piping:

1. Insulate refrigerant piping with 1" thick Armaflex. Coat exterior piping with approved paint.

C. Ductwork:

1. Air conditioning, and outside air ductwork shall be insulated as herein noted. External insulation may be omitted where ducts are acoustically lined.
2. External Insulation:

- a. For concealed ductwork provide fiberglass blanket with FRJ aluminum jacket. Blanket shall be wired on, with all joints overlapped, pasted and sealed.
 - b. For ductwork exposed in fan rooms, mechanical rooms, Basement accessible attics and outdoors, provide 3# density rigid fiberglass board (2" thick) with ASJ cover. Install with stick clips and corner beads. Tape all joints, seams and clips.
3. Thickness: Unless otherwise noted, all heating and ventilating and air conditioning ducts and make-up air and dishwasher exhaust duct, shall be insulated to thickness specified. Unless otherwise noted, thickness as follows:
- | | |
|-------------------|----------|
| Supply and Return | 2" thick |
| Outside Air | 2" thick |

1.9 FOUNDATIONS, SUPPORTS, SLEEVES AND PLATES

- A. Unless otherwise noted, HC shall provide all foundations, hangers, and supports for his equipment including piping, air conditioning units, fans, fin pipe radiation and covers, ductwork, etc.
- B. All ductwork, piping, wiring, and equipment shall be hung or supported from structural members only.
- C. Ductwork shall be supported in accord with SMACNA Standards.
- D. Piping:
 1. All pipe shall be supported from building structure in a neat and workmanlike manner wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. Use of wire or perforated metal to support pipes will not be permitted.
 2. Spacing of pipe supports shall not exceed 8' for pipes up to 1-1/2" and 10' on all other piping.
 3. Finned pipe shall be supported on wall brackets. All piping shall be supported to allow free movement where expanding or contracting. Pipe shall be anchored as required or directed.
 4. All horizontal pipe, where run overhead or on walls, shall be supported as follows, unless otherwise indicated:
 - a. On adjustable steel clevis type hangers suspended on hanger rods, pipe sizes up to and including 4".
 5. All supports shall be fastened to structural members or additional steel supports provided by HC. Where connecting to bar joists, connections shall be made at panel points.
 6. Where pipes pass through masonry, concrete walls, foundations, or floors, HC shall set such sleeves as are necessary for passage of pipes. These sleeves shall be of sufficient size to permit 1" of insulation to be provided around pipe passing through. HC shall be responsible for exact location of these sleeves.
 7. Sleeves shall not be used in any portion of building where use of same would impair strength or construction features of the building. Insert for supporting

lateral pipes and equipment shall be placed and secured to form work, and all sleeve insert locations shall be thoroughly checked with Architect so as not to conflict with other trades.

8. Where pipes pass through floor or walls, they shall be provided with chromium plated escutcheons.
9. All piping passing from floor or walls to finned pipe enclosure or panel radiators shall be provided with sleeves of same material and finish as adjacent enclosure.
- E. Unless otherwise noted, auxiliary steel supports for support of all mechanical equipment as required for particular applications or as directed and indicated on Drawings shall be by HC. All equipment hung from overhead construction shall have weight or equipment distributed by use of angle or channel iron beams as necessary and approved or substantially fastened to beams used for building structural support.
- F. All operating equipment shall be supported so as to produce the minimum amount of noise transmission.
- G. Provide vibration isolation devices for support of all equipment having moving parts.
- H. Provide curb rails, Pate or equivalent for mounting of roof mounted equipment, condensing units, etc.

1.10 SHOP DRAWINGS

- A. All manufactured and fabricated items shall be submitted for review before installation of same. Submission shall be in form of manufacturer's standard printed sheets, pamphlets or bulletins and shall be clearly indicated thereon as to size, type, etc.
- B. Before fabricating any work, HC shall prepare and submit drawings of all ductwork and complicated piping including coordination of lighting, ceiling grid, structural steel and connections to related equipment showing all dimensions and details of construction and installation. No work is to be fabricated until shop drawings are reviewed. Shop drawings shall be 3/8" equal to 1'-0" minimum scale.
- C. Review of submission shall mean review of equipment and/or fabrications as to design and performance only. Contractor shall be responsible for scheduling quantities, physical size to suit allowable space, electrical characteristics, etc.
- D. Any additional costs incurred due to substitution of equipment (e.g., electrical, structural, etc.) shall be borne by HC.
- E. The following items require a submission of shop drawings:
 1. Ductwork
 2. Hangers and supports
 3. Condensing Unit
 4. Gas Furnace
 5. Exhaust fans
 6. Diffuser, registers and grilles
 7. Motor controls
 8. Temperature controls

1.11 START-UP, TESTS AND ADJUSTMENTS

- A. Unless otherwise specified, all new and altered piping systems shall be hydrostatically tested to 100 psig. Test shall be four (4) hour duration, during which time piping shall show no leaks and during time no sealing of leaks will be permitted.
- B. Balancing shall be done by a certified balancing firm. An allowance of four (4) additional four (4) hour periods shall be made to rebalance air and/or water flows, if found necessary
- C. Balancing shall be done by a certified testing and balancing firm, NEBB, AABC or other nationally recognized organization.
- D. HC shall balance out all systems and submit test reports showing operational data to include the following:
 - 1. Motor power consumption for fans and pumps
 - 2. Air quantities at each outlet and each inlet
 - 3. Fan RPM and total air quantities for supply, return, outside and exhaust air
 - 4. Discharge and inlet static pressures
 - 5. Motor size and amperage draw for each fan.
- E. HC shall furnish services of a qualified person, thoroughly familiar with job, to operate and make all adjustments so that system and control equipment shall operate as intended. This person shall make adjustments including balancing of water and air systems in cooperation with qualified representative of mechanical equipment manufacturers and temperature control manufacturer. Architect is to be notified when this balancing is to be performed.
- F. When all work is in an acceptable operating condition, Owner shall be furnished with trade literature, parts lists, and operating instructions for all equipment furnished.
- G. Contractor shall furnish one glass framed set and two sets not framed of operating and maintenance instructions, control circuits, and charts with the number of all critical valves corresponding to 2" brass numbered valve discs chained to these valves to Architect.
- H. Final inspection and review shall be made only after proper completion of all of the above requirements.
- I. As part of the operating and maintenance manual HC shall provide a detailed listing of the equipment installed. As a minimum the listing shall include:
 - 1. Unit type
 - 2. Unit designation
 - 3. Unit location
 - 4. Area or areas served by unit
 - 5. Starter location
 - 6. Unit manufacturer
 - 7. Model number
 - 8. Scheduled capacity
 - 9. Electrical, Volts, Phase, Amps
 - 10. Motor HP
 - 11. Filter type, quantity and sizes
 - 12. Belt quantity and model

1.12 CONDENSING UNIT

- A. Refer to drawings for capacity, model and manufacturer.

1.13 GAS FURNACE

- A. Refer to drawings for capacity, model and manufacturer.

1.14 COOLING COIL

- A. Provide a cased cooling coil as shown and scheduled on drawings.
- B. Coil design do an excellent job of water management. The coils are designed to avoid water blow-off into the ducts by directing condensate away from the fins and into the drain pan.
- C. Each coil is equipped with a corrosion-resistant condensate drain pan. The condensate drain pan is designed with a slope to help ensure proper drainage, improved moisture removal, and home comfort.
- D. Condensate pan features two ¾ inch female threaded brass insert connections. The unique brass inserts provide for a leak-free condensate line connection to prevent water damage.
- E. Coils are provided with proven sweat-connections for leak-free operation maintaining system reliability.
- F. These coils meet or exceed burst pressure of 2100 psi which is at least three to five times the pressure they will see in actual application.
- G. Thermostatic Expansion Valve (TXV) – All Carrier coils have refrigerant-specific factory-installed TXV's.
- H. The ring, installed inside the liquid line connection at the TXV, is the best option for preventing refrigerant leaks and future service calls.
- I. Protect the durable copper tubing from being damaged during the manufacturing and installation process.

1.15 HEAT PUMP SPLIT SYSTEM

- A. Provide a Mitsubishi or equivalent Inverter System.
- B. System components and capacity shall be as scheduled on the drawings.
- C. Outdoor unit shall be an inverter driven S unit.
- D. Indoor units to be wall mounted units.

1.16 EXHAUST FAN

- A. Refer to drawings for type, capacity, model and manufacturer.

1.17 DIFFUSERS, REGISTERS AND GRILLES

- A. Provide where shown on Plans, diffusers, registers and grilles of sizes and types indicated on Drawings. Unless otherwise noted on Plans, units shall be by Titus or equivalent.
- B. Catalog numbers and performance data are based on models scheduled on Drawings. Noise levels of all air terminals shall not exceed those of units specified. Velocity of air in the breathing zone shall not exceed 50' per minute.
- C. A complete schedule of diffusers, registers and grilles shall be prepared and submitted for review.
- D. Supply-Air Registers shall be extruded aluminum construction of the double deflection type, with opposed blade volume dampers. Volume damper blades shall overlap when closed eliminating any possibility of air leakage. Dampers shall be operated by means of removable key. Provide deflectors for all supply air registers, wherever registers are shown connected at right angles to branch duct servicing same.
- E. Return-air and Exhaust-Air Registers shall be extruded aluminum construction of the single deflection type, with opposed blade volume dampers and horizontal face bars. Dampers shall be operated by means of removable key.
- F. Supply-Air Diffusers: Shall be extruded aluminum construction of the adjustable pattern throw-type for ceiling or duct installations as required. Diffusers shall have multi-blade volume dampers and air distributing grids, supplied by same manufacturer as the diffuser proper. Volume damper shall be operated from below. Blank off quadrants of diffuser as noted to attain one, two or three-way blow. Furnish with grid for uniform air flow.
- G. Where noted on plans, provide linear supply diffuser of type scheduled, or noted on drawings. Diffusers shall be of extruded aluminum, bar stock type and where in floor, shall be reinforced for floor use.
- H. Finish of diffusers, registers and grilles shall be in baked enamel of color selected by the Architect.
- I. All air terminals shall be furnished by the manufacturer with sponge rubber gaskets around the frame periphery to provide an air tight seal against the wall or ceiling into which the air terminal is set. Gaskets shall be no less than 1/4" thick, and shall be securely glued to the inside surface of the frame.

1.18 MOTOR CONTROLLERS AND WIRING

- A. HC shall furnish all necessary electrical controls, motor starter, switches, etc., for proper operation of equipment furnished by him under this Contract, and as herein noted.
- B. Separate magnetic starter with thermal overload protection shall be used for all motors 1/2 HP and over. All magnetic starters shall have phase loss protection module. For motors 20 HP and above, provide reduced voltage starters.

- C. All starters shall have Hand-Off-Auto push buttons and pilot lights.
- D. Separate manual starter with thermal overload protection for all motors 1/3 HP and under.
- E. Provide non-fused disconnect switches at exhaust fans.
- F. Electric service is 120/208 volt, 3 phase, 4 wire, 60 cycle. All motors ½ HP and under shall be wired for 120-volt, single phase; motors 1/2 HP and over shall be 208 volts, 3 phase, exceptions as specified.
- G. Provide all auxiliary contacts and controls required for interlocks and automatic operation of HVAC equipment as noted under temperature control specifications. Control circuit voltage shall not exceed 120 volts. Provide fused control transformers where required.
- H. HC shall be responsible for the proper electrical connections which will be done by EC and shall supply said EC with all necessary wiring diagrams to complete this installation.

1.19 ELECTRIC MOTORS

- A. High efficiency motors shall be provided with all of the equipment furnished under this section.
- B. Minimum efficiencies for 1800 motors shall be in accord with NEMA MG-1, as follows:

Motor Size	Minimum Rated Efficiency
1 HP	85.5%
1 ½	86.5
2	86.5
3	89.5
5	89.5
7 ½	91.0
10	91.7
15	93.0
20	93.0
25	93.6
30	94.1
40	94.1
50	94.5

- C. Fractional horsepower motors shall be high efficiency, permanent split capacitor type.

1.20 AUTOMATIC TEMPERATURE CONTROL SYSTEM

- A. Provide all labor and material for a complete electric/electronic low voltage system of temperature controls.
- B. Work shall be complete in all respects, including labor, transformers, materials and necessary services, and shall be installed by competent mechanics.

- C. Complete control drawings shall be submitted for approval before field installation is started. The drawings shall give a complete description of all control elements complete air flow diagrams locating instruments, valves, etc. and show all wiring. In addition, the submittal shall include manufacturer's data sheets on each control component and a sequence of operation.
- D. All electrical wiring, including but not limited to power, control and miscellaneous conduit, connections, etc., required for the installation and operation of the ATCS, will be furnished and installed by the H.C. Any wiring exposed in public spaces must be concealed or installed in Wiremold, (finish as per Architect). Provide drawings indicating Wiremold runs for review and approval by Architect/Engineer prior to any installations. All wiring must comply with NEC, State and Local Codes.
- E. Sequence of Operation

- 1. Furnaces

- a. Provide a seven (7) day programmable room thermostat to start the unit during occupied times and stop the unit during unoccupied times.
- b. Room thermostat to cycle heating stages of furnace to maintain space temperature.
- c. Furnace with AC: the condensing unit shall be cycled to maintain room temperature. When the unit is on in the occupied heating cycle, the condensing unit shall be off.
- d. For the unoccupied, the units shall cycle to maintain reduced temperature.
- e. Provide dual entry controller and motorized dampers.

- 2. Exhaust Fans to operate under control of 7-day digital programmable time clock.

1.21 ALTERNATES

- A. Alternate No. 1: Provide 2 ½ ton heat pump system, refer to drawing H-102 for details.

1.22 GUARANTEE

- A. Refer to Section 235000

END OF SECTION