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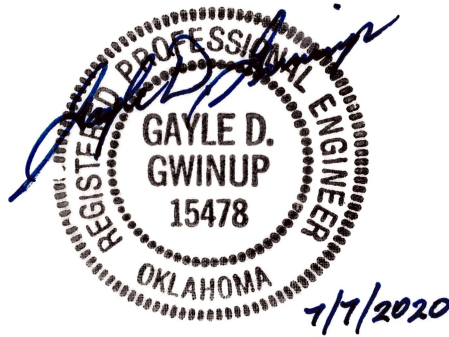
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SECTION 220400
PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Work Included: Provide plumbing where shown on the Drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to:
 - 1. Domestic hot and cold water piping system.
 - 2. Drain, waste, and vent systems.
 - 3. Gas piping system.
 - 4. Plumbing fixtures and trim as shown on the Drawings.

- B. Related Work: Documents affecting Work of this Section include, but are not necessarily limited to: General Conditions, Supplementary, and Sections in Division 1 of these Specifications.

- C. Drawings: The mechanical drawings show the general arrangement of piping, equipment, and appurtenances and shall be followed as closely as actual building construction, site conditions, and the work of other trades will permit. The mechanical work shall conform to the requirements shown on all of the drawings. General and structural drawings shall take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly.

1.2 QUALITY ASSURANCE:

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.

- B. Codes and Regulations:
 - 1. In addition to complying with the specified requirements, comply with pertinent regulations of governmental agencies having jurisdiction, all applicable laws, codes, and ordinances including those of the state, county and city.
 - 2. The Work shall also comply with all applicable requirements of the National Fire Protection Association, International Building, Plumbing and Mechanical Codes, and all locally accepted amendments to these codes.
 - 3. In the event of conflict between or among specified requirements and pertinent regulations, the more stringent requirement will govern.
 - 4. Non-compliance: Should the contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards, and utility company regulations, he shall bear all costs arising in correcting the deficiencies.

- C. Certificate of Final Inspection: Under each applicable section of the specifications, the contractor shall, upon completion of the work under that section, furnish a certificate of final inspection from the department having jurisdiction.

1.3 EXAMINATION OF SITE:

- A. Visit the site, inspect the existing Conditions and check the Drawings and Specifications so as to be fully informed of the requirements for completion of the Work.
- B. Lack of such information shall not justify a request for extra compensation to the contract price.

1.4 MATERIAL AND EQUIPMENT:

- A. All materials and equipment shall be new, those of the same type shall be by the same Manufacturer, and shall be of the best quality and design and free from defects.
- B. A Manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating Manufacturer's name, address and catalog number.
- C. Manufacturer's name and model numbers used herein and on the Drawings establish type and quality required. Equal products may be considered if submitted in writing to the Engineer/Architect for approval 10 days prior to bid date. The Contractor shall be responsible for assuring the items and equipment substituted for those shown on the Drawings will physically fit in the space allocated.
- D. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection until installed. All items subject to moisture damage (such as controls) shall be stored in dry, conditioned spaces.
- E. Protection: Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury. Damage or defects developing before acceptance of the work shall be made good at the contractor's expense.
- F. Dimensions: It shall be the responsibility of the contractor to insure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall furnish and install sizes and shapes of equipment so that the final installation shall suit the true intent and meanings of the drawings and specifications.
- G. Manufacturer's Directions: Shall be followed completely in delivery, storage, protection and installation of all equipment and materials. The contractor shall promptly give notice in writing of any conflict between any requirement of the Contract Documents and the manufacturer's directions and shall obtain written instructions before proceeding with the work. Should the contractor perform any work that does not

comply with the manufacturer's directions or such written instructions, he shall bear all costs arising in correcting the deficiencies.

1.5 SUBMITTALS:

- A. Comply with pertinent provisions of Division 1.
- B. Product Data: After the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Manufacturer's Specifications, catalog cuts, and other data needed to prove compliance with the specified requirements.
 - 3. Shop Drawings and other data as required indicating method of installing and attaching equipment, except where such details are fully shown on the Drawings.
 - 4. All sheets of the submittal shall have the job name stamped or permanently written neatly on them and shall be assembled in an indexed brochure. The descriptive material shall be arranged in the brochure in the same order as found in the specifications. Each brochure shall be submitted in a hardback, 3-ring binder. The leading sheet of the descriptive material for each item shall be full size, of heavy paper, with a numbered outside tab, and an index sheet showing the location in the brochure.
 - 5. Manufacturer's regular catalog sheets will not be acceptable under these requirements unless they indicate completely all of the specification requirements. Where drawings cover several sizes or types of construction, they shall clearly indicate the size or type of construction to be used on the project. In cases where several sizes of the same type of equipment are required to be furnished, the submittal shall include a schedule identifying each piece of equipment, complete with all capacity information needed to compare every submittal item with its respective specified item. Special features shall be listed on a separate typewritten sheet.
 - 6. Brochures shall contain a certification by the Contractor that the equipment or materials are suitable for conditions shown and specified; that the equipment or materials are believed to be in conformity with the plans and specifications, except as may be specifically described; be signed by the Contractor. Brochures received not in conformity with these requirements will be returned for required action.
 - 7. Finding "APPROVED" or "APPROVED AS NOTED" shall not eliminate responsibility for compliance with the plans and specifications, unless specific attention has been called, in writing, to the proposed deviations at the time of transmittal of the brochures and such deviations have been found acceptable, nor shall it eliminate the responsibility for freedom from errors of any sort in the data submitted. Discovery of such deviations at or after installation shall be cause for immediate replacement at no additional cost to the Owner.
 - 8. No material or equipment so governed shall be ordered until found acceptable by the Architect/Engineer/Owner.
- C. Sterilization Certificate: Upon completion of water line sterilization, deliver to the Owner two copies of an acceptable "Certificate of Performance" for that activity.
- D. Record Drawings:
 - 1. Comply with pertinent provisions of Division 1.

- a. Record Drawings- The contractor shall furnish to the owner CAD record drawings consisting of three (3) sets of 11" x 17" prints (To be bound in O&M Manuals), one (1) full size set of prints and one (1) disk, showing the piping and ductwork for the HVAC and plumbing systems. Piping sizes, rerouting, etc., for both under floor and above ceiling piping shall be shown. Also, provide a blue-line of the site plan, clearly marked, to indicate any and all changes in sanitary sewer, storm sewer, domestic cold water and natural gas piping to the building. In addition to these drawings, a complete set of approved ductwork shop drawings and temperature control shop drawings shall be included in this set of drawings.
 - 1) CAD Record drawings shall incorporate all change and field orders. (No separate or supplemental drawings).
 - 2) All equipment schedules to be revised to reflect installed manufacturer model numbers and capabilities.
- 2. Include a copy of the Record Drawings in each copy of the operation and maintenance manual as described below. (Original document shall be reproducible paper.)
- E. Manuals: Upon completion of the Work of this Section, deliver to the Architect two copies of an operation and maintenance manual compiled in accordance with the provisions of Division 1 of these Specifications. Include within each manual:
 - 1. Copy of the approved record documents for this portion of the Work.
 - 2. Copies of all warranties and guarantees.
 - 3. Description of equipment control and seasonal operation, including schedule of required maintenance.

1.6 INSPECTION:

- A. Make written notice to the Owner adequately in advance of each of the following stages of construction:
 - 1. In the underground Condition prior to placing concrete floor slab, when all associated Work is in place.
 - 2. When all rough-in is complete, but not covered.
 - 3. At completion of the Work of this Section.
- B. When material and/or workmanship is found to not comply with the specified requirements, within three days after receipt of notice of such non-compliance, remove the non-complying items from the job site and replace them with items complying with the specified requirements, all at no additional cost to the Owner.

1.7 PRODUCT HANDLING:

- A. Comply with pertinent provisions of Division 1.

1.8 CLEANING, TESTING AND PLACING IN SERVICE:

- A. Immediately prior to final inspection, the Contractor shall make a final cleanup of dirt and refuse resulting from his Work and shall assist in keeping the premises clean at all times.
- B. Immediately prior to final inspection, the Contractor shall clean all material and equipment installed under this Contract. Dirt, dust, plaster, stains and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original Condition.
- C. Mechanism of all equipment shall be checked, adjusted and tested for proper operation. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required to produce the intended performance.

1.9 ADJUSTMENT AND INSTRUCTION:

- A. Energize all systems, equipment and fixtures and check for proper operation.
- B. The Contractor's service personnel shall instruct the Owner's Representative in the proper operation of all systems.

1.10 GUARANTEE:

- A. The Contractor guarantees all Work against any defects due to faulty workmanship or material and that all raceways, ducts, and piping are free from foreign material, obstructions, holes, or breaks of any nature.
- B. Upon written notice from the Architect or Owner, the Contractor shall promptly remedy without cost to the Owner any defects occurring within a period of one (1) year from the date of final acceptance.

1.11 WARRANTY:

- A. The Contractor shall properly execute in the Owner's name all Manufacturer's standard warranty certificates applying to equipment installed on the project and shall deliver said certificates to the Architect at completion of the job. All warranty cards shall also be properly executed and delivered to the supplier or Manufacturer's records. Standard warranties for equipment shall not be less than one (1) year.

PART 2 - PRODUCTS

2.1 PIPE SCHEDULE:

- A. Drain, Waste, and Vent System:
 - 1. For sanitary Work below the floor and outside underground:

- a. Provide service weight cast iron pipe and fittings or Schedule 40 PVC or ABS DWV pipe if allowed by local codes.
 - b. Soil lines 5'-0" or more away from the structures may be Schedule 40 PVC.
 - 2. Above ground:
 - a. Provide service weight cast iron pipe and fittings with No-Hub joints. Schedule 40 PVC or ABS DWV pipe may be used in lieu of cast iron if allowed by local codes. All above ground rain water piping shall be cast iron and insulated.
- B. Water System (domestic piping):
- 1. Above ground, provide Type "L" copper with sweated connections.
 - 2. Below grade, provide Type "K" copper with sil-fossed connections. Schedule 40 PVC may be used for water service, if allowed by local codes.
- C. Gas Piping:
- 1. Underground piping equal to Republic X-Tru-Coat plastic coated black steel pipe with protective wrap over joints.
 - a. Piping 2" and smaller: Threaded fittings.
 - b. Piping 2-1/2" and larger: Welding fittings.
 - 2. Above ground piping shall be black steel.
 - 3. Gas service piping up to the building shall be continuous plastic pipe meeting ASTM D2513 and D2517.

2.2 MATERIALS:

- A. Cast Iron Soil Pipe and Fittings:
- 1. Provide service weight cast iron conforming to ASTM A74 and CISPI 301, or provide hubless type per above standards. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International.
- B. Galvanized:
- 1. Provide standard weight complying with ASTM A53 and A120 for above ground piping. (Galvanized not allowed underground or under slab floors.)
- C. Copper Pipe:
- 1. Provide copper pipe conforming to ASTM B42 and B302. (Type "M" copper not allowed underground or under slab floors.)
- D. Copper Tube:
- 1. Provide copper tube conforming to ASTM B75, B88, and B251. (Type "M" copper not allowed underground or under slab.)
- E. Polyvinyl Chloride Pipe:
- 1. Provide PVC pipe conforming to ASTM D2665 for waste, vent, and drainage pipe above and underground within 5'-0" of the building.
 - 2. Provide PVC pipe conforming to ASTM D2265 for building sewer pipe.
 - 3. Provide PVC pipe conforming to ASTM D1785 for water service pipe.

- F. Black Steel Pipe:
 1. Provide black steel pipe conforming to ASTM A53 and A120.
- G. Fittings:
 1. 2" and smaller provide standard cast iron threaded fittings.
 2. 2-1/2" and larger provide standard Butt Welding fittings.
- H. Unions:
 1. For copper lines, provide copper unions.
 2. For connections in iron pipe lines:
 - a. 2" and smaller provide ground joint brass-to-iron fittings.
 - b. 2-1/2" and larger provide standard cast iron with flanged ends and gaskets.

2.3 VALVES:

- A. All valves of the same type shall be by the same Manufacturer.
- B. Gate Valves: Provide solid wedge disc, rising stem, 200# WOG; non-rising stem valves may be used only where there is insufficient clearance. Sweat joint valves shall be used on all copper pipes.
 1. 2" and smaller, rising stem: Provide Hammond #IB-640, bronze, screwed, B-62 bronze body and stem, malleable iron handwheel.
 2. 2" and smaller, non-rising stem: Provide Hammond IB-645, bronze, screwed, B-62 bronze body and stem, malleable iron handwheel.
 3. 2-1/2" and larger: Provide Hammond #IR-1140, IBBM, flanged, non-rising stem.
- C. Globe Valves: Provide replaceable composition disc suitable for 200°F water.
 1. 2" and smaller: Provide Hammond #IB-413T, bronze, screwed, malleable iron hand wheel.
 2. 2-1/2" and larger: Provide Hammond #IR-116, iron body, flanged, 200# WOG.
- D. Ball Valves: Provide large port ball of chrome plated, bronze or stainless steel construction, screwed ends, quarter turn operation, lever or C-handle operator. Valve shall be rated for 150 psi steam, 600 psi WOG. Valve shall have blow out proof stem and adjustable packing nut.
 1. 2" and smaller: Hammond #8501 Series or approved equal.
- E. Gas Cocks:
 1. 2" and smaller: Provide bronze, screwed, lubricated square head valve equal to Resun #R-1430.
 2. 2-1/2" and larger: Provide Nordstrom #142 or #143.
- F. Check Valves:
 1. 2" and smaller: Provide Hammond #IB-940, bronze, screwed, Y-pattern, 200# WOG, swing check type.
 2. 2-1/2" and larger: Provide Hammond #IR-1124, IBBM, flanged, 200# WOG.
- G. Strainers: Provide Y-pattern, 200# WOG, 20 mesh stainless perforated screen free area, equal to 4 times pipe area.

1. 2" and smaller: Provide Wilkins #YSBR Series, screwed.
 2. 2-1/2" and larger: Provide Wilkins #FS Series, flanged.
- H. Plumbing Fixture Service Valves:
1. 1/2" angle valve with wheel handle stop, 1/2" I.P.S. female inlet, 3/8" tube compression fitting outlet, 3/8" chrome plated flexible riser and chrome plated escutcheon plate. Chicago Faucet #1015 or equal.

2.4 FLASHING:

- A. Where pipes of this Section pass through the roof, flash with Semco, #1100-4 seamless 4 lb. flashing, with steel reinforced "Vari-Pitch" boot and cast iron counterflashing sleeve or equal method approved by the Architect.

2.5 PIPE HANGERS:

- A. Water Piping:
1. Provide Fee and Mason #212 split ring hangers with supporting rods.
 2. Copper plated hangers or hangers with dielectric isolators to be installed for copper pipe.
- B. Soil and Waste Piping:
1. Provide Fee and Mason #212 adjustable ring hangers with supporting rods.
 2. Use Fee and Mason #241 riser clamps at each floor and as required.
- C. Gas Piping:
1. Provide Fee and Mason #241 split ring hangers with supporting rods.

2.6 CLEANOUTS:

- A. Exterior:
1. Provide Wade W-6030-Z, or Smith #4253 with XH cast iron top in concrete areas.
- B. Floors:
1. Provide Wade W-6030-1 or Smith #4023 with round nickle bronze top in finished room floors.
 2. Provide Wade W-6030-Z or Smith #4223 with round cast iron top in unfinished room floors.
 3. Provide "flush-with-floor" type cleanouts, with adjustable watertight covers and integral anchoring flange with clamping collar where waterproofing membrane is used.
- C. Finished Walls:
1. Provide Wade W-8460-R6 or Smith #4532 with round chrome plate or stainless steel access plate and screw.
- D. Provide cleanout plugs of extra heavy bronze.

2.7 ACCESS BOXES:

- A. Walls:
 - 1. Provide Wade W-8480-ST or Smith #4730 with polished chrome plate face in tile walls.
 - 2. Provide Wade W-8490-AKL, Smith #4760-AKL or #4765-AKL with bonderized prime-coated steel face and with Allen locks in walls of other finished rooms.
- B. Ceilings:
 - 1. Provide Acorn DW Series bonderized prime-coated steel face with Allen lock.
- C. Floors:
 - 1. Provide Wade W-8300-S or Smith #4910 with XH nickel-bronze non-skid top.
 - 2. Provide Wade W-8300-S, Smith #4920 for floors covered with vinyl reinforced or pure vinyl tile.

2.8 TRAPS:

- A. For lavatories and sinks, except service sinks, provide chrome plated cast brass traps with brass nuts. Provide deep seal traps where required and/or shown on the Drawings.
- B. For handicap lavatories, provide off-set tailpiece ahead of P-trap.

2.9 WATER HAMMER ARRESTORS:

- A. Provide Smith #5000 series or Precision Plumbing Products, Inc. stainless steel.

2.10 INSULATION:

- A. Insulate hot water, cold water, and condensate piping with ½” thick glass fiber preformed pipe insulation with factory applied all purpose glass fiber reinforced flame retardant kraft paper and aluminum foil self sealing lap.
- B. Elbows and fittings to be insulated with factory preformed PVC jacketed insulation material to match thickness of pipe insulation.
- C. Valve bodies shall be insulated with Armstrong Armaflex type “FR” or equal insulation with vapor barrier. Factory preformed insulation enclosures may be substituted for field applied insulation.
- D. Insulated waste traps receiving cooling coil condensate and piping for a minimum of 10 feet after trap with ½ inch Armstrong Armaflex type “FR” or equal insulation with vapor barrier.
- E. Where shown on the Drawings or required by governmental agencies having jurisdiction, at lavatories for handicapped persons provide TRUEBRO Inc. Handi Lav-Guard model #102W and #105W white finish insulation on hot water supply, cold water supply, tailpiece, and trap.

2.11 FIXTURES AND EQUIPMENT:

- A. Provide plumbing fixture, trim, (exposed trim to be chrome plated) and equipment as shown on the "Plumbing Fixture Schedule" in the Drawings. China fixture shall be of the best grade vitreous ware without pit holes and blemishes. The Architect reserves the right to reject any pieces which, in his opinion, are faulty.
 - 1. For the purpose of identification only one Manufacturer's model numbers are used throughout the schedule shown on the Drawings.
 - 2. Approved Manufacturers: American Standard, Crane, Kohler, or Eljer.

- B. Cover Plates (Escutcheons):
 - 1. Provide chrome plated brass equal to Beaton Corbin Company style 2-BC for copper tube and 13-BC for standard pipe.

- C. Floor Drains:
 - 1. Provide floor drains where indicated on the Drawings complete with deep seal P-trap as listed below for various floor conditions:
 - a. Linoleum or asphalt tile floor - Wade W-1100-STD-1 with nickle bronze raised lip strainer.
 - b. Quarry tile or Terrazzo floor - Wade W-1100-G-1 with nickle bronze square strainer.
 - c. General - Wade W-1100 with type B nickle bronze strainer:
 - 1) 2" drain to have 5" strainer;
 - 2) 3" drain to have 6" strainer;
 - 3) 4" drain to have 8" strainer.
 - d. Heavy duty - Wade W-1200-13-5 with 12" diameter secured coated iron grate.
 - e. Manufacturers - Zurn, Wade, or J.R. Smith.

2.12 INSULATION:

- A. Insulate hot water, cold water, condensate, and refrigerant suction lines with 1/2" thick IMCOA Polyolefin Insulation or Armstrong Armaflex type "FR" with vapor barrier.

- B. Also see requirements specified for "Handicap Fixture Insulation."

2.13 SLEEVES:

- A. Where pipes pass through concrete, masonry, or stud walls, or pass through ceilings, provide 20-gauge galvanized sheet metal sleeve large enough to allow for free movement of the pipes with expansion.

2.14 OTHER MATERIALS:

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS:

- A. Examine the areas and Conditions under which Work of this Section will be performed. Correct Conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory Conditions are corrected.

3.2 PLUMBING SYSTEM LAYOUT:

- A. Lay out the plumbing system in careful coordination with the Drawings, determining proper elevations for all components of the system and using only the minimum number of bends to produce a satisfactorily functioning system.
- B. Follow the general layout shown on the Drawings in all cases except where other Work may interfere.
- C. Lay out pipes to fall within partition, wall, or roof cavities, and do not require furring other than as shown on the Drawings. Do not install domestic water lines in exterior walls without proper considerations of required insulation and routing.
- D. Slots, Chases, Openings, and Recesses: Through floors, walls, ceilings, and roofs as specified in new structure will be provided by the various trades in their respective materials, but the trade requiring them shall see that they are properly located and shall do any cutting and patching caused by the neglect to do so. No cuts shall be made into any structural element, beam or column, without written approval. Opening in existing structures will be provided by the trade requiring same.
- E. Locations: Of pipes, ducts, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The contractor shall determine the exact route and location of each pipe, duct and electrical raceway prior to fabrication.
 - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example, plumbing drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
 - 2. Offsets, transitions and changes in direction in pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the drawings. The contractor shall furnish and install all traps and sanitary vents, etc., as required to effect these offsets, transitions and changes in direction.

3.3 TRENCHING AND BACKFILLING:

- A. Perform trenching and backfilling associated with the Work of this Section in strict accordance with the provisions of Division 2 of these Specifications.

- B. Cut bottom of trenches to grade. Make trenches 12" wider than the greatest dimension of the pipe.
- C. Bedding and Backfilling:
 - 1. Install piping promptly after trenching. Keep trenches open as short a time as practicable.
 - 2. Under the building, install pipes on a 6" bed of damp sand. Backfill to bottom of slab with damp sand.
 - 3. Outside the building, install underground piping on a 6" bed of damp sand. Backfill to within 12" of finish grade with damp sand. Backfill remainder with native soil.
 - 4. Do not backfill until installation has been approved and Project Record Documents have been properly annotated.
 - 5. Provide bare copper trace wire 6 inches above all buried plastic pipe.
 - 6. Provide continuous plastic banner labeled CAUTION-GAS PIPING 12 inches above all buried gas piping.

3.4 INSTALLATION OF PIPING AND EQUIPMENT, GENERAL:

- A. General:
 - 1. Proceed as rapidly as the building construction will permit. Install piping parallel and perpendicular to building walls and partitions.
 - 2. Thoroughly clean items before installation. Cap pipe openings to exclude dirt until fixtures are installed and final connections have been made.
 - 3. Cut pipe accurately, and work into place without springing or forcing, properly clearing windows, doors, and other openings. Excessive cutting or other weakening of the building will not be permitted.
 - 4. Show no tool marks or threads on the exposed plated, polished, or enameled connections from fixtures. Tape all finished surfaces to prevent damage during construction.
 - 5. Make changes in directions with fittings; make changes in main size with eccentric reducing fittings. Unless otherwise noted, install water supply and return piping with straight side of eccentric fittings at top of the pipe.
 - 6. Run horizontal sanitary piping at a uniform grade of 1/4" per ft., unless otherwise noted. Branch connections and changes in direction to be made with 45 degree "Y" fittings or long sweep ells.
 - 7. Run horizontal water piping with an adequate pitch upward in direction of flow to allow complete drainage.
 - 8. Install vent connections on all fixtures, traps, and equipment connected to the soil and waste system and extend not less than 3'-6" above floor before turning horizontal. Extend vent through roof minimum 1'-0" above roof or adjacent wall within 18" of roof penetration.
 - 9. Provide sufficient swing joint, ball joints, expansion loops, and devices necessary for a flexible piping system, whether or not shown on the Drawings. Make branch connections with offsets to provide for pipe movement.
 - 10. Support piping independently at pumps, coils, tanks, and similar locations, so that weight of pipe will not be supported by the equipment.
 - 11. Pipe drain lines from drip pans, air vents, relief valves and similar locations, to spill over an open sight drain, floor drain, or other acceptable discharge point, and terminate with a plain end, unthreaded pipe 2" above the drain.

12. Securely bolt all equipment, isolators, hangers, and similar items in place.
13. Support each item independently from other pipes. Do not use wire for hanging or strapping pipes.
14. Provide complete dielectric isolators between ferrous and non-ferrous metals.
15. Provide union and shut-off valves suitably located to facilitate maintenance and removal of equipment and apparatus.
16. Provide shut-off gas valve and union at each piece of gas fired equipment .
17. Valves, strainers, check valves, and fittings shall be full size of the line they serve unless noted otherwise.
18. Make change in pipe size noted on the plans after last fitting of larger pipe. When supply pipes are larger than equipment tapings, reduce size immediately prior to entry.

B. Equipment Access:

1. Install piping, equipment, and accessories to permit access for maintenance. Reroute pipe and/or relocate items as necessary to provide such access, and without additional cost to the Owner.
2. Provide access doors where valves, motors, or equipment requiring access for maintenance are located in walls or chases or above ceilings. Coordinate location of access doors with other trades as required.

3.5 PIPE JOINTS:

A. Copper Tubing:

1. Cut square, remove burrs, and clean inside of female fitting to a bright finish.
 - a. Apply solder flux with brush to tubing.
 - b. Remove internal parts of solder-end valves prior to soldering.
2. Provide dielectric unions at points of connection of copper tubing to ferrous piping and equipment.
3. For joining copper tubing, use:

a. Water piping 3" and smaller	:	95-5 solder.
b. Water piping larger than 3"	:	"Sil-fos" brazing.
c. Underground	:	"Sil-fos" brazing.

B. Screwed Piping:

1. Deburr cuts.
 - a. Do not ream exceeded internal diameter of the pipe.
 - b. Thread to requirements of ANSI B2.1.
2. Use teflon tape on male thread prior to joining other services.
3. Use litharge and glycerin on joint prior to cleaning for air and oil piping.

C. Plastic Piping:

1. Mechanical joints shall be made with an Elastomeric thread seal on male thread. Joint shall be clean and free of dirt and made in accordance with Manufacturer's instructions. (DWV piping to conform to ASTM D3212.)
2. Solvent Cementing:
 - a. Clean joint surfaces free of dirt and moisture.
 - b. Prime joint with colored primer past extend of joint.
 - c. Apply cement to all joint surfaces and make joint while cement is still wet.

- d. Use Solvent Cement for particular pipe material and make joint in accordance with Manufacturer's instructions.
- 3. Threaded joints shall be made in using lubricant or tape approved for pipe material applied to male thread. Threads of joints shall conform to ANSI B2.1 and shall be clean of dirt immediately prior to making joint.
- D. Welded Piping:
 - 1. Welded pipe to be joined in accordance with American Welding Society Code using butt-welded single V beveled 45 degrees to within 1/16" of inside wall. Use welding fittings for changes of direction and intersection of lines.
- E. Leaky Joints:
 - 1. Remake with new material.
 - 2. Remove leaking section and/or fitting as directed.
 - 3. Do not use thread cement or sealant to tighten joint.

3.6 PIPE SUPPORTS:

- A. Support suspended piping with clevis or trapeze hangers and rods.
- B. Space hangers and support for horizontal steel pipes according to the following schedule:

<u>Pipe Size</u>	<u>Maximum Spacing on Centers</u>
1-1/4" and smaller	: 8'-0"
1-1/2" to 3"	: 10'-0"
4" to 5"	: 14'-0"
- C. Space hangers and supports for horizontal copper tubing according to the following schedule:

<u>Tube Size</u>	<u>Maximum Spacing on Centers</u>
1" and smaller	: 6'-0"
1-1/2"	: 7'-0"
2"	: 8'-0"
2-1/2"	: 9'-0"
3" and larger	: 10'-0"
- D. Space hangers and supports for horizontal cast iron soil pipe 5'-0" on center.
- E. Space hangers and supports for horizontal PVC and ABS plastic pipe 4'-0" on center.
- F. Provide sway bracing on hangers longer than 18".
- G. Support vertical piping with riser clamps secured to the piping and resting on the building structure. Provide at each floor unless otherwise noted.
- H. Provide insulation continuous through hangers and rollers. Protect insulation by galvanized steel shields.
- I. Arrange pipe supports to prevent excessive deflection, and to avoid excessive bending stress.

- J. Support piping from inserts or anchors in concrete slabs. Provide the inserts under this Section and arrange for the placing under Section 03300 of these Specifications. Use expansion inserts only where approved by the Architect.
- K. Hubless Piping:
 - 1. Provide hangers on the piping at each side of, and within 6" of, hubless pipe coupling so the coupling will bear no weight.
 - 2. Do not provide hangers on couplings.
 - 3. Provide hangers adequate to maintain alignment and to prevent sagging of the pipe.
 - 4. Make adequate provisions to prevent shearing and twisting of the pipe and the joint.

3.7 SLEEVES AND OPENINGS:

- A. Provide sleeves for each pipe passing through walls, partitions, floors, roofs, and ceilings.
 - 1. Set pipe sleeves in place before concrete is poured.
 - 2. For uninsulated pipe, provide sleeves two pipe sizes larger than the pipe passing through, or provide a minimum of 1/2" clearance between inside and outside of the pipe.
 - 3. For insulated pipe, provide sleeves of adequate size to accommodate the full thickness of pipe covering, with clearance of packing and caulking.
- B. Caulk the space between sleeve and pipe or pipe covering, using a noncombustible, permanently plastic, waterproof, non-staining compound which leaves a smooth finished appearance, or pack with noncombustible cotton, rope, or fiberglass to within 1/2" of both wall faces, and provide the waterproof compound described above.
- C. Finish and Escutcheons:
 - 1. Smooth any rough edges around sleeves with plaster or spackling compound.
 - 2. Provide 1" wide chrome or nickel plated escutcheons in all pipes exposed to view where passing through walls, floors, partitions, ceilings, and similar locations.
 - a. Size the escutcheons to fit pipe and covering.
 - b. Hold escutcheons in place with set screw.

3.8 CLEANOUTS:

- A. Accessible cleanouts shall be installed in all horizontal waste lines at no greater than 100 ft. intervals and at the base of all vertical stacks.
- B. Secure the Owner's approval of locations for cleanouts in finished areas prior to installation.
- C. Provide cleanouts of same nominal size as the pipes they serve; except where cleanouts are required in pipes 4" and larger, provide 4" cleanouts.
- D. Make cleanouts accessible. After pressure tests are made and approved, thoroughly graphite the cleanout threads.

3.9 VALVES:

- A. Provide valves in water, air, and gas systems. Locate and arrange so as to give complete regulation of apparatus, equipment, and fixtures.
- B. Provide valves in at least the following locations:
 - 1. In branches and/or headers of water piping serving a group of fixtures.
 - 2. On both sides of apparatus and equipment.
 - 3. For shutoff of risers and branch mains.
 - 4. For flushing and sterilizing the system.
 - 5. Where shown on the Drawings.
- C. Locate valves for easy accessibility and maintenance.

3.10 WATER HAMMER ARRESTORS:

- A. Provide water hammer arrestors on hot water lines and cold water lines.
 - 1. Install in upright position at all quick closing valves, solenoids, isolated plumbing fixtures, and supply headers at plumbing fixture groups.
 - 2. Locate and size as specified or as shown on the Drawings and, where not shown, locate in accordance with Plumbing and Drainage Institute Standard WH-201.
 - 3. Install water hammer arrestors behind access panels.
- B. Where fixtures are not protected by water hammer arrestors, provide air compression chambers equal to twelve (12) pipe diameters, 18" minimum on all water supply connections.

3.11 BACKFLOW PREVENTION:

- A. Protect plumbing fixtures, faucets with hose connections, yard hydrants, lawn irrigation, and other equipment having plumbing connection, against possible back-siphonage.

3.12 PLUMBING FIXTURE INSTALLATION:

- A. Installation:
 - 1. Set fixtures level and in proper alignment with respect to walls and floors, and with fixtures equally spaced.
 - 2. Provide supplies in proper alignment with fixtures and with each other.
 - 3. Provide flush valves in alignment with the fixture, without vertical or horizontal offsets.
 - 4. Install all fixture supports before wall finish is applied.
- B. Grout wall and floor mounted fixtures watertight where the fixtures are in contact with walls and floors.
- C. Caulk deck-mounted trim at the time of assembly, including fixture and casework mountings. Caulk self-rimming sinks installed in casework.

- D. All fixtures shall be cleaned before setting and the installation shall be left ready for use.

3.13 DISINFECTION OF WATER SYSTEMS:

- A. Sterilize domestic hot and cold water systems to meet Health Department requirements.
 - 1. Prior to treatment, flush the system of all dirt and foreign matter.
 - 2. Fill system with water treated with 50 ppm of chlorine. Leave treated water in the systems for 24 hours.
 - 3. Open all valves and faucets several times during flushing and treatment filling to insure full circulation.
 - 4. Test the chlorine content at the end of treatment period and if chlorine content is greater than 10 ppm, flush the system. If chlorine content is found to be less than 10 ppm, repeat the sterilization process. Take samples from several points in the system.
 - 5. After sterilization, flush the system with clean water until the chlorine is less than 0.1 ppm.
- B. After final flushing, obtain Health Department Certificate of Approval on samples of water taken from the systems. (Use a testing agency approved by the Health Department.) Test shall show negative for coli-aerosene organisms.
- C. If analysis results are not satisfactory, repeat the disinfection procedures and retest until specified standards are achieved.

3.14 OTHER TESTING AND ADJUSTING:

- A. Provide personnel and equipment, and arrange for and pay the costs of, all required tests and inspections required by governmental agencies having jurisdiction.
- B. Test the following systems at the pressures listed:
 - 1. Gas piping: Test under 30 psi air pressure.
 - 2. Domestic water: Test under 130 psi hydrostatic pressure.
 - 3. Soil and waste:
 - a. Above ground test with 12 ft. water head;
 - b. Underground test with 8 ft. water head.
- C. Where tests show materials or workmanship to be deficient, replace or repair as necessary, and repeat the tests until the specified standards are achieved.
- D. Adjust the piping systems to optimum standards of operation.

END OF SECTION

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PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Work Included: Provide heating, ventilating, and air conditioning systems where shown on the Drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to:
1. Packaged air-cooled, 100% outdoor air. gas/electric conditioning systems, complete with direct-expansion cooling section, burner gas valve and heat exchanger, energy recovery, dampers, damper operators, mounting frame, operating and safety controls, blowers, motors, compressors, condensers, filters, and related items.
 2. Split system direct expansion VRF heat pump heating and cooling system with controls, safety controls, blowers, motors, electric strip heaters, compressors, coils, filters, and related items.
 3. Air conditioning supply and return ductwork system with grilles, diffusers, registers, dampers, sheet metal hardware, and related items.
 4. Exhaust systems including, motors, ductwork, grilles, registers, controls and related items.
 5. Temperature control system.
 6. Air systems balance for air quantities shown on the plans.
 7. Acoustical and thermal insulation of ducts, piping, and equipment.
- B. Related Work: Documents affecting Work of this Section include, but are not necessarily limited to General Conditions, Supplementary Conditions, and Sections in Division 1 of this Specification.
- C. Drawings: The mechanical drawings show the general arrangement of piping, equipment, and appurtenances and shall be followed as closely as actual building construction, site conditions, and the work of other trades will permit. The mechanical work shall conform to the requirements shown on all of the drawings. General and structural drawings shall take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly.

1.2 QUALITY ASSURANCE:

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.
- B. Codes and Regulations:
1. In addition to complying with the specified requirements, comply with pertinent regulations of governmental agencies having jurisdiction, all applicable laws, codes, ordinances including those of the state, county and city.
 2. The Work shall also comply with all applicable requirements of the National Fire Protection Association, International Building, Plumbing and Mechanical codes, and all locally accepted amendments to these codes.
 3. In the event of conflict between or among specified requirements and pertinent regulations, the more stringent requirement will govern.

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4. Pay all fees, taxes, licenses and permits for inspection and certification for the execution of this Work.
 5. Non-compliance: Should the contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards, and utility company regulations, he shall bear all costs arising in correcting the deficiencies.
- C. Certificate of Final Inspection: Under each applicable section of the specifications, the contractor shall, upon completion of the work under that section, furnish a certificate of final inspection from the department having jurisdiction.

1.3 EXAMINATION OF SITE:

- A. Visit the site, inspect the existing Conditions and check the Drawings and Specifications so as to be fully informed of the requirements for completion of the Work.
- B. Lack of such information shall not justify a request for extra compensation to the contract price.

1.4 MATERIAL AND EQUIPMENT:

- A. All materials and equipment shall be new, of the same type and Manufacturer, and shall be of the best quality and design and free from defects.
- B. A Manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating Manufacturer's name, address and catalog number.
- C. Manufacturer's name and model number used herein and on the Drawings establish type and quality required. Equal products may be considered if submitted in writing to the Engineer/Architect for approval 10 days prior to bid date. The Contractor shall be responsible for assuring the items and equipment substituted for those shown on the Drawings will physically fit in the space allocated.
- D. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection until installed. All items subject to moisture damage (such as controls) shall be stored in dry, conditioned spaces.
- E. Protection: Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury. Damage or defects developing before acceptance of the work shall be made good at the contractor's expense.
- F. Dimensions: It shall be the responsibility of the contractor to insure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall furnish and install sizes and shapes of equipment so that the final installation shall suit the true intent and meanings of the drawings and specifications.
- G. Manufacturer's Directions: Shall be followed completely in delivery, storage, protection and installation of all equipment and materials. The contractor shall promptly give notice in writing of any conflict between any requirement of the Contract Documents and the manufacturer's directions and shall obtain written instructions before proceeding with the work. Should the

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contractor perform any work that does not comply with the manufacturer's directions or such written instructions, he shall bear all costs arising in correcting the deficiencies.

1.5 SUBMITTALS:

- A. Comply with pertinent provisions of Division 1.

- B. Product Data: After the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Manufacturer's Specifications, catalog cuts, and other data needed to prove compliance with the specified requirements.
 - 3. Shop Drawings and other data as required to indicate method of installing and attaching equipment, except where such details are fully shown on the Drawings.
 - 4. Hard Copy Submittals
 - a. All sheets of the submittal shall have the job name stamped or permanently written neatly on them and shall be assembled in an indexed brochure. The descriptive material shall be arranged in the brochure in the same order as found in the specifications. Each brochure shall be submitted in a hardback, 3-ring binder. The leading sheet of the descriptive material for each item shall be full size, of heavy paper, with a numbered outside tab, and an index sheet showing the location in the brochure.
 - b. Manufacturer's regular catalog sheets will not be acceptable under these requirements unless they indicate completely all of the specification requirements. Where drawings cover several sizes or types of construction, they shall clearly indicate the size or type of construction to be used on the project. In cases where several sizes of the same type of equipment are required to be furnished, the submittal shall include a schedule identifying each piece of equipment, complete with all capacity information needed to compare every submittal item with its respective specified item. Special features shall be listed.
 - c. Brochures shall contain a certification by the Contractor that the equipment or materials are suitable for conditions shown and specified; that the equipment or materials are believed to be in conformity with the plans and specifications, except as may be specifically described; be signed by the Contractor. Brochures received not in conformity with these requirements will be returned for required action.
 - d. Paper submittals shall be packaged complete for the project and not submitted as individual equipment or material items unless determined to be necessary for meeting the project schedule and approved by the Engineer.
 - e. Include transmittal form clearly identifying the information which is being submitted for review.
 - 5. Electronic Submittals
 - a. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file as noted above for paper submittals. Name PDF file with submittal number.
 - b. Transmit PDF package via e-mail to Architect for distribution. Include transmittal form clearly identifying the information which is being submitted for review.
 - 6. Contractor's submittal shall include statement of review by the submitting contractor and the Construction Manager that the submitted equipment and materials have been reviewed for coordination with other work and compliance with the Contract Documents. This includes but not limited to electrical, field dimensions, integration within building systems, review of Owner required features, Work of other trades. Include name of reviewer for submitting contractor and for Construction Manager. Engineer reserves the right to withhold action on a submittal not including Contractor's Statement of Review by the Contractor and the Construction Manager.

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7. Finding "APPROVED EQUAL" or "NO EXCEPTION TAKEN" shall not eliminate responsibility for compliance with the plans and specifications, unless specific attention has been called, in writing, to the proposed deviations at the time of transmittal of the brochures and such deviations have been found acceptable, nor shall it eliminate the responsibility for freedom from errors of any sort in the data submitted. Discovery of such deviations at or after installation shall be cause for immediate replacement at no additional cost to the Owner.
8. No material or equipment so governed shall be ordered until found acceptable by the Architect/Engineer/Owner.
9. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Record Drawings:

1. Comply with pertinent provisions of Division 1.
 - a. Record Drawings- The contractor shall furnish to the owner CAD record drawings consisting of three (3) sets of 11" x 17" prints (To be bound in O&M Manuals), one (1) full size set of prints and one (1) disk, showing the piping and ductwork for the HVAC systems. Piping sizes, rerouting, etc., for both underfloor and above ceiling piping shall be shown. Also, provide a blue-line of the site plan, clearly marked, to indicate any and all changes in sanitary sewer, storm sewer, domestic cold water and natural gas piping to the building. In addition to these drawings, a complete set of approved ductwork shop drawings and temperature control shop drawings shall be included in this set of drawings.
 - 1) CAD Record drawings shall incorporate all change and field orders. (No separate or supplemental drawings).
 - 2) All equipment schedules to be revised to reflect installed manufacturer model numbers and capabilities.
2. Include a copy of the Record Drawings in each copy of the operation and maintenance manual described below. (Original document shall be reproducible paper.)

D. Manuals: Upon completion of this portion of the Work, and as a Condition of its acceptance, deliver to the Architect two copies of an operation and maintenance manual compiled in accordance with the provisions of Division 1 of these Specifications. Include within each manual:

1. Copy of the approved record documents for this portion of the Work.
2. Copies of all warranties and guarantees.
3. Description of HVAC equipment control and seasonal operation, including schedule of required maintenance.

1.6 INSPECTION:

- A. Make written notice to the Owner adequately in advance of each of the following stages of construction:
 1. In the underground condition prior to placing concrete floor slab, when all associated Work is in place.
 2. When all rough-in is complete, but not covered.
 3. At completion of the Work of this Section.
- B. When material and/or workmanship is found to not comply with the specified requirements, within three days after receipt of notice of such non-compliance, remove the non-complying items from the job site and replace them with items complying with the specified requirements, all at no additional cost to the Owner.

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1.7 PRODUCT HANDLING:

- A. Comply with pertinent provisions of Division 1.

1.8 CLEANING, TESTING AND PLACING IN SERVICE:

- A. Immediately prior to final inspection, the Contractor shall make a final cleanup of dirt and refuse resulting from his Work and shall assist in keeping the premises clean at all times.
- B. Immediately prior to final inspection, the Contractor shall clean all material and equipment installed under this Contract. Dirt, dust, plaster, stains and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original Condition.
- C. Mechanism of all equipment shall be checked, adjusted and tested for proper operation. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required to produce the intended performance.

1.9 ADJUSTMENT AND INSTRUCTION:

- A. Energize all systems, equipment and fixtures and check for proper operation. Mechanical contractor shall prove all HVAC systems operate as designed in cooling and heating modes with required outdoor air settings prior to turning over equipment to Owner for installation of controls.
- B. HVAC system shall be placed in operation and balanced to provide air flow as indicated on the Drawings.
- C. The Contractor's service personnel shall instruct the Owner's Representative in the proper operation of all systems.

1.10 GUARANTEE:

- A. The Contractor guarantees all work against any defects due to faulty workmanship or material and that all raceways, ducts and piping are free from foreign material, obstructions, holes or breaks of any nature.
- B. Upon written notice from the Architect or Owner, the Contractor shall promptly remedy without cost to the Owner any defects occurring within a period of one (1) year from the date of final acceptance.

1.11 WARRANTY:

- A. The Contractor shall properly execute in the Owner's name all Manufacturer's standard warranty certificates applying to equipment installed on the project and shall deliver said certificates to the Architect at completion of the job. All warranty cards shall also be properly executed and delivered to the supplier or Manufacturer's representative for Manufacturer's records. Standard warranties for equipment shall not be less than one (1) year.

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PART 2 - PRODUCTS

2.1 SHEET METAL DUCTWORK:

- A. For interior heating, ventilating, and air conditioning systems, provide best grade, prime, open hearth, galvanized sheet metal ducts fabricated and installed to pertinent ASHRAE and SMACNA standards, or to the requirements of governmental agencies having jurisdiction, whichever requirement is more stringent.
- B. Round ductwork to be constructed of best grade prime, open hearth galvanized steel with spiral seams. For systems with less than .75" W.G. pressure, round duct with longitudinal snap lock seams and beaded sleeve transverse joints may be installed.
- C. Exposed sheet metal ductwork shall be prepared for application of final paint finish.

2.2 FLEXIBLE DUCT:

- A. Provide factory fabricated insulated low pressure flexible duct with the following attributes as manufactured by Thermaflex, Wire Mold, Metallflex, or Flexmaster.
 - 1. Helix wire flexible core.
 - 2. 2" fiberglass blanket insulation of 3/4 lb. density with continuous sealed vapor barrier jacket.
 - 3. Accessories shall include strap clamps, spin-in duct taps, air scoops and dampers as required.
 - 4. Composite assembly, including insulation and vapor barrier, shall meet all requirements of UL 181, including flame spread of 25 or less and smoke developed rating of 50 or less as set forth in NFPA Bulletin 90-A, and bearing UL label as a Class 1 air duct.
 - 5. Flexible duct only allowed above accessible ceilings.

2.3 DUCTWORK FABRICATION:

- A. All interior ductwork and fittings shall be fabricated in accordance with recommendations as outlined in current ASHRAE and SMACNA Standards.
- B. Gauges and reinforcing in accordance with current ASHRAE and SMACNA Standards for greatest dimensions of duct or housing.
- C. Lap metal ducts in direction of air flow. Hammer down edges and slip joints to leave smooth duct interior.
- D. Cross break all rectangular ducts 18" and larger. Omit cross breaking if two gauge heavier metal is used in duct construction.
- E. Transverse Joints: Ductwork up to 24", use s-drive, pocket, or bar slip. Ductwork 25" to 40", use joints forming outside ribs. Other joint connections of equivalent mechanical strength and air tightness may be used if approved by the Engineer.
- F. Construct elbows with radius of not less than 1-1/2 times width of duct on center line or square elbows with air foil turning vanes. Round duct elbows shall be of the smooth radius type. For round duct systems with less than .75" W.G. pressure, jointed elbows may be installed and located in concealed locations.

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- G. Branch ducts shall be tied to main trunk duct through radius take-off and splitter damper, or 45 degree branch and curved blade extractor. Round branch duct tappings to be of the conical or spin-in type with air scoop and volume damper for supply air on 12" round and smaller. Flanged or bellmouth taps used for larger ducts as noted on the Drawings.
- H. Transitions shall be constructed per SMACNA Standards and shall not exceed 20 degrees for diverging air flows or 30 degrees for contracting air flows.
- I. Plenums shall be fabricated in accordance to duct gauges and shall be reinforced per SMACNA standards.
- J. Exterior duct joints to be hard cast and sealed water tight. Provide aluminum jacket for exposed exterior ductwork with 1 inch rigid fiberglass insulation between duct and jacket.

2.4 DUCT HANGERS AND SUPPORTS:

- A. Hangers shall be galvanized steel band iron or angle iron and galvanized threaded rod. Wall supports shall be galvanized steel band iron or fabricated angle bracket.

2.5 DUCT INSULATION:

- A. General:
 - 1. Provide materials complying with NFPA Bulletin 90-A, as determined by UL method NFPA 225-ASTM E84, and complying with the governing code, with flame spread rating less than 25 and smoke developed rating less than 50.
 - 2. Where vapor barriers are used, provide intact and continuous throughout with all joints sealed.
 - 3. Manufacturer of duct liners shall print density and thickness on face of duct liner.
 - 4. Acceptable Manufacturers:
 - a. Owens/Corning Fiberglass
 - b. Johns-Manville
 - c. Certainteed
 - d. Armstrong
- B. Ductliner (Interior Rectangular Duct): Insulate internal supply, return and exhaust ducts with 1" glass fiber with a minimum density of 1.5 pounds per cubic foot. Liner to be coated to prevent fiber erosion at air velocities up to 4000 f.p.m.
- C. Ductwrap (Round Duct): Insulate externally all round ducts and fresh air ducts with 2" thick, 1 pound density, fiberglass ductwrap with factory applied reinforced aluminum foil vapor barrier.
- D. Sound Attenuation Liner: Insulate supply and return air ductwork at unit connections and first lengths of duct with 2" thick, 3 pound density, duct liner. Liner to be coated to prevent fiber erosion at air velocities up to 4000 f.p.m.
- E. External Board: (Interior Rectangular Duct) Insulate externally rectangular ducts with mineral or glass fibers bonded with a thermosetting resin. For duct and plenum applications, provided with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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2.6 Factory-Applied Jackets

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jacket are indicated, comply with the following:
1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 DUCTWORK ACCESSORIES:

- A. Acceptable Manufacturers:
1. Air Balance, Inc.
 2. Ruskin
 3. Carnes
 4. Pottorff
 5. Krueger
 6. United Enertech
 7. Nailor Industries
- B. Access Doors: Access doors shall be installed for inspection, service, and maintenance of balance dampers, fire dampers, filters, etc. Doors shall be 12" x 12" for handhole and 24" x 24" for manhole where required. Access doors shall have gasket seals, insulated core and shall be secured air tight.
- C. Flexible Connections: Duct connections to fans and where noted elsewhere on plans shall be sound isolation of fire resistant, water proof, and mildew-resistant canvas. Connections shall not be less than 4" long, shall have suitable metal collar frame on each end, and shall be made with at least 1" slack material.
- D. Opposed Blade Dampers:
1. Construct of galvanized steel blades a maximum width of 6" set in 18-gauge galvanized steel frame with blade stops. Damper blades to be equipped with rigid linkage bar and pivoted using noncorrosive bearings of oilite or nylon.
 2. Single or parallel multiple blade dampers shall be of the same quality of construction, but shall not be used unless noted on the Drawings.
- E. Back Draft Dampers: Construct of all aluminum parallel blades a maximum width of 4-1/2" with felt or vinyl tips, 16-gauge aluminum frame with blade stops. Damper blades to be pivoted using noncorrosive bearing of oilite or nylon and shall have blade linkage with adjustable counterbalance as noted.

2.8 AIR OUTLETS:

- A. Provide and install grilles, registers, and diffusers as scheduled on the Drawings with accessories as noted.
- B. Acceptable Manufacturers:
1. Metalaire
 2. Titus
 3. Tuttle & Bailey
 4. Barber Colman
 5. Krueger
 6. Nailor Industries

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- C. Flanged frame grilles, registers, and diffusers to have gasket seals.
- D. Provide insulated plenums, adaptor boxes or square to round transitions for connection to flexible duct runouts where required.

2.9 ROOF HOODS:

- A. Provide and install all aluminum roof hoods with bird screens as sized and noted on the Drawings. Backdraft dampers and other accessories to be furnished and installed as noted on the Drawings.
- B. Acceptable Manufacturers:
 - 1. Penn
 - 2. Greenheck
 - 3. Cook
 - 4. Carnes
 - 5. Acme
 - 6. Or as provided by fan Manufacturer when installed in conjunction with exhaust or supply fan systems.

2.10 VIBRATION ISOLATION:

- A. Vibration isolation shall be of the type and deflection for the duty indicated on the Drawings. The vibration isolator supplier shall confirm equipment weights and revolutions (Frequency) with actual products approved and installed by Division 23 Contractor.
- B. All vibration isolators and bases shall be treated for resistance to corrosion.
- C. Size type and deflection of isolators shall conform to recommendations set forth in ASHRAE standards.
- D. Approved Manufacturers:
 - 1. Amber Booth
 - 2. Mason Industries, Inc.
 - 3. Consolidated Kinetic Corporation

2.11 EXHAUST FANS:

- A. Exhaust fans shall be of the type and capacity as scheduled on the Drawings. All fans bear seal of ratings certified by A.M.C.A. Fans shall be furnished and installed with accessories, special coatings, special materials and construction, and controls as noted on the Drawings.
- B. Approved Manufacturers:
 - 1. Penn
 - 2. Greenheck
 - 3. Cook
 - 4. Carnes

2.12 VRF SPLIT SYSTEM HEAT PUMP:

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- A. Provide heating and cooling split system fan coil airhandling unit, evaporator/condenser coil in fan unit, air cooled variable capacity outdoor heat pump unit with reversing valve, of the capacities and voltage as scheduled on the Drawings.
- B. Fan coil outdoor heat pump unit shall be of the same Manufacturer and matched for the capacities scheduled on the Drawings. Performance ratings shall comply with those scheduled for the outdoor and coil entering air design data listed on the Drawings.
- C. Fan Coil Features:
 - 1. Cabinet: Constructed of cold-rolled steel finished with baked enamel and fully insulated; duct connection flanges; filter frame and access door; and removable access panels for servicing.
 - 2. Fan: Direct drive, multi-speed blower, dynamically and statically balanced; fan motor overload protection; resilient mounting.
 - 3. DX Coil: Copper tube and mechanically bonded aluminum fins; refrigerant metering device; refrigerant line fittings; condensate drain pan with primary and secondary drain line fittings.
- D. Variable capacity heat Pump Features: Galvanized heavy gauge steel with enamel finish housing; high efficiency variable capacity scroll spring isolated compressor with crankcase heater and noise shield; thermal and current-sensitive overload protection; compressor internal high pressure protection; outdoor coil construction of copper tube with mechanically bonded aluminum fins; four way valve control; coil refrigerant metering device mounted at liquid service valve; direct drive, propeller condenser fan with factory lubricated, inherently protected, and resiliently mounted motor; low pressure switch; suction line accumulator; pressure relief device; automatic defrost control; liquid line solenoid valve; charging valves; liquid line filter dryer; compressor and condenser fan starters; EER and C.O.P. ratings to meet local code requirements for unit performance.
- E. Accessories: Extra set of throwaway filters to install after final acceptance; relays; transformers for control wiring; unit thermostat control as described in Temperature Control Section; precharged refrigerant lines when applicable for distance and routing.
- F. Acceptable Manufacturers:
 - 1. Lennox
 - 2. Mitsubshi
 - 3. Daikin

2.13 AIR COOLED CONDENSING UNITS:

- A. Provide air cooled condensing units with the capacities and voltage as scheduled on the drawings..
- B. Features:
 - 1. Cabinet: Constructed of cold-rolled steel finished with baked enamel and fully insulated; duct connection flanges; filter frame and access door; and removable access panels for servicing.
 - 2. Fan: Direct drive, multi-speed blower, dynamically and statically balanced; fan motor overload protection; resilient mounting.
 - 3. DX Coil: Copper tube and mechanically bonded aluminum fins; refrigerant metering device; refrigerant line fittings; condensate drain pan with primary and secondary drain line fittings.
 - 4. .

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- C. Heat Pump Features: Galvanized heavy gauge steel with enamel finish housing; hermetic spring isolated compressor with crankcase heater and noise shield; thermal and current-sensitive overload protection; compressor internal high pressure protection; outdoor coil construction of copper tube with mechanically bonded aluminum fins; coil refrigerant metering device mounted at liquid service valve; direct drive, propeller condenser fan with factory lubricated, inherently protected, and resiliently mounted motor; low pressure switch; suction line accumulator; pressure relief device; automatic defrost control; liquid line solenoid valve; charging valves; liquid line filter dryer; compressor and condenser fan starters; EER and C.O.P. ratings to meet local code requirements for unit performance.
- D. Accessories: Relays; transformers for control wiring; precharged refrigerant lines when applicable for distance and routing.
- E. Acceptable Manufacturers:
 - 1. Lennox
 - 2. Carrier
 - 3. Trane
 - 4. Or Owner approved equal.

2.14 REFRIGERANT PIPING:

- A. Precharged and factory insulated refrigerant lines shall be installed for distances less than 50 feet and direct, unconcealed pipe routing. Refrigerant piping shall be type "L" copper, refrigerant grade with wrought copper fittings and with minimum ½ inch Armstrong Armaflex type "FR" or equal insulation.
- B. Pipe sizes shown on the Drawings are for estimating purposes only. Equipment Manufacturer shall verify size of refrigerant piping for system installation.
- C. Refrigerant system shall include liquid filter dryer, strainer, charging valves, relief valves, check valves, sight glass, solenoid valves, and thermostatic expansion valves.

2.15 MAKEUP AIR ROOF TOP UNITS (GAS HEAT AND ELECTRIC DX COOLING):

- A. Provide indirect gas fired heating and cooling packaged makeup air unit with electric DX cooling, single zone, gas fired heating section with capacities and voltage as scheduled on the Drawings.
- B. Unit Features: Insulated weatherproof galvanized steel cabinet with baked enamel finish, 409 stainless steel end shot heat exchanger, redundant gas valve, intermittent pilot ignition, modulating burner from 20-100%, power flue exhaust, A.G.A. approved for outdoor application, down turn discharge plenum, combination return/outside air intake plenum, weather hood, evaporator and condenser coils with aluminum plate fins mechanically bonded to seamless copper tubes, thermal expansion valve, hermetic compressors with motor overload protection and 12.5-100% modulation, crankcase heater and vibration isolators, hot gas reheat coil and reheat control, modulating condenser fan speed control, centrifugal forward curve fan with vibration isolators, direct drive motor, condensing propeller fans with direct drive motor, low temperature operation to 0° F, short cycling protection, freezestat, 316 stainless steel evaporator drain pan, 2 inch filter section with dirty filter pressure switch, single point power connection, factory installed deadfront disconnect switch, convenience outlet, phase/voltage failure relay, factory roof curb.

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- C. Provide factory installed energy wheel, outside air and return air mixing damper section with powered exhaust and weather hood. Provide extruded aluminum airfoil damper blades with rubber edge seals and aluminum end seals. Individual damper control motors and drives. (Class 1A)
- D. Controls: Control panel with microprocessor, damper 3 position control, supply air temperature control, dehumidification control based on mixed air dew point, hot gas reheat supply air control, outside air temperature compressor lockout control,
- E. Approved Manufacturers:
 - 1. Modine
 - 2. Hastings
 - 3. Or Owner approved equal.

2.16 OTHER MATERIALS:

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect/Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS:

- A. Examine the areas and Conditions under which Work of this Section will be performed. Correct Conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory Conditions are corrected.

3.2 COORDINATION:

- A. Coordinate as required with other trades to assure proper and adequate provision in the Work of those trades for interface with the Work of this Section.
- B. Slots, Chases, Openings, and Recesses: Through floors, walls, ceilings, and roofs as specified in new structure will be provided by the various trades in their respective materials, but the trade requiring them shall see that they are properly located and shall do any cutting and patching caused by the neglect to do so. No cuts shall be made into any structural element, beam or column, without written approval. Opening in existing structures will be provided by the trade requiring same.
- C. Locations: Of pipes, ducts, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The contractor shall determine the exact route and location of each pipe, duct and electrical raceway prior to fabrication.
 - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example, plumbing drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
 - 2. Offsets, transitions and changes in direction in pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not

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indicated on the drawings. The contractor shall furnish and install all traps and sanitary vents, etc., as required to effect these offsets, transitions and changes in direction.

3.3 PREPARATION:

- A. Flashing:
 - 1. Where items of this Section penetrate the roof, outer walls or waterproofing of any kind, provide under this Section all base flashing and counterflashing required at such penetration.
 - 2. Provide on each pipe passing through the roof a 4 lb. seamless lead flashing and counterflashing assembly. Penetrations through sheet metal roofs shall be installed per roofing Manufacturer's recommendations.

3.4 EQUIPMENT INTERFACE:

- A. Provide all required shutoff valves, unions, and final connections of piping to the Work of this Section.
- B. For electrically operated equipment, verify the electrical characteristics actually available for the Work of this Section and provide equipment meeting those characteristics.

3.5 DUCTWORK INSTALLATION:

- A. Rigidly support all interior ductwork using angle iron and galvanized threaded rods or galvanized strap hangers spaced to carry the load but not less than 5'-0" on centers and secured to the building structure in a method approved by the Architect. All hangers shall be installed truly vertical. Ductwork shall be hung level except where Architectural or structural Conditions dictate otherwise.
- B. Flexible ductwork shall not exceed 5'-0" runout total length from tapping to diffuser connection. Make smooth radius bends and secure duct at each end using a method of mechanical fastening with air tight seal. Support duct from resting on ceiling using strap hangers.
- C. Fabric ductwork to be secured to metal duct via strap band secured behind beaded duct collar or manufacturer's standard means and methods of attachment. Secure suspension system to duct reinforced connectors to support duct. Suspension system to be installed in accordance with manufacturer's installation requirements and recommendations and in compliance with Architect and Structural Engineer directives for installation and support of duct systems.
- D. Clean duct system of dirt and debris prior to operating any fan connected to the duct system. Cap all floor outlets and open ductwork during construction until final connections are made.
- E. Duct sizes shown on the Drawings are internal clear dimensions. The Contractor shall adjust for thickness of duct liner required.

3.6 DUCT HANGER AND SUPPORT INSTALLATION:

- A. Duct hangers and supports to be secured to the building structure via a method approved by the Architect.

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- B. Hanger Minimum Sizes:
 - 1. Up to 30" wide: 1" x 16 ga. at 5 feet spacing.
 - 2. 31" to 48" wide: 1-1/2" x 16 ga. at 5 feet spacing.
 - 3. Over 48" wide: 1-1/2" x 16 ga. at 8 feet spacing.

- C. Horizontal Duct on Wall Supports Minimum Sizes:
 - 1. Up to 18" wide: 1-1/2" x 16 ga. galvanized steel strap or 1" x 1" x 1/8" angles at 8 feet spacing.
 - 2. 19" to 40" wide: 1-1/2" x 1-1/2" x 1/8" angles at 4 feet spacing.

- D. Vertical Duct on Wall Supports Minimum Sizes:
 - 1. At 6'-0" spacing:
 - a. Up to 24" wide: 1-1/2" x 16 ga.
 - b. 25" to 36" wide: 1" x 1" x 1/8"
 - c. 37" to 48" wide: 1-1/4" x 1-1/4" x 1/8"

3.7 INSULATION:

- A. Duct liner shall be adhered to interior sides of ductwork with minimum 50% coverage of fire retardant adhesive. Coat all exposed edges with adhesive. Use mechanical fasteners, (12-gauge impale anchor tabs or equal) maximum 16" on centers. Cut off excess fastener length and cover with brush coat of mastic. Liner shall be cut to fit and be without gaps at all joints. Just before sections of ductwork are hung, coat end butt joints of duct liner with adhesive and hang immediately.

- B. Ductwrap shall be firmly secured to ductwork with adhesive applied in 6" widths on 16" centers. Securely fasten insulation in place with 16-gauge annealed tie wire spirals wound 16" on center for straight duct runs and half hitched around duct on 4" centers for elbows and fittings OR tape longitudinal seams on straight duct runs with 2" tape. Butt insulation and seal joints and breaks with 2" tape or foil adhered to vapor barrier. Do not stretch or compress insulation excessively during application.

3.8 DUCTWORK ACCESSORIES:

- A. Install items in accordance with Manufacturer's instructions and accepted methods.

3.9 AIR OUTLETS:

- A. Install all grilles, registers, and diffusers and their accessories in accordance with Manufacturer's instructions and accepted methods.

- B. Paint interior of all ductwork visible behind air outlets matt black.

- C. Review requirements of outlet sizes, finish, mounting, and air patterns prior to installation. Coordinate location of outlets and make necessary adjustments to conform with Architectural features, symmetry, and light locations. Refer to grille, register and diffuser list for additional requirements.

3.10 ROOF HOODS:

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- A. Set roof hoods on factory or field built curbs and connect to ductwork as shown on the Drawings. Flash, caulk, and seal weather tight per Manufacturer's instructions and Architectural details.

3.11 VIBRATION ISOLATION:

- A. Install vibration isolators in accordance with Manufacturer's instructions.

3.12 EXHAUST FANS:

- A. Install fans in accordance with Manufacturer's instructions and accepted methods.
- B. Set roof mounted fans on factory or field built curbs and connect to ductwork as shown on the Drawings. Fans manufactured for sloped roofs to be flashed into roofing per Manufacturer's instructions. Flash, counterflash, caulk, and seal water tight per Manufacturer's instructions and Architectural details.
- C. Vibration isolation shall be included in all fan mounting methods as required in the "Vibration Isolation" Section of these Specifications above and as detailed on the Drawings.
- D. Owner shall secure control contractor under separate contract to perform installation of unit control interface with building HVAC systems controls.

3.13 SPLIT SYSTEM HEAT PUMP:

- A. Install in accordance with code requirements and Manufacturer's instruction, adhering to required clearances for operation and servicing. Division 23 Contractor to complete ductwork, refrigerant piping, mounting and condensate connections for a fully functional system. Division 26 Contractor to rough-in and make final connections of required electrical power wiring. Owner shall secure control contractor under separate contract to perform installation of unit control interface with building HVAC systems controls.
- B. Refrigerant system to be tested and fully charged and complete for a fully functional system.

3.14 REFRIGERANT PIPING:

- A. Install refrigerant piping parallel and perpendicular to building structure. Route piping as directly between equipment as possible, using only the minimum number of bends required. Support and hang piping with copper or plastic coated hangers space as required for copper tubing. Joints and fittings to be sweat with SIL-FOS or equivalent silver bearing solder.
- B. Test refrigerant system with Nitrogen at 300 psi.

3.15 MAKEUP AIR ROOF TOP UNITS:

- A. Install in accordance with code requirements and Manufacturer's instructions adhering to required clearances for operation and servicing. Division 23 Contractor to complete ductwork, gas piping, refrigerant piping, and condensate connections for a fully functional system. Division 26 Contractor to rough-in and make final connections of required electrical power

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wiring. Owner shall secure control contractor under separate contract to perform installation of unit control interface with building HVAC systems controls.

- B. Set roof mounted unit on factory curb. Secure unit to curb with tie down clips. Flash, counterflash, caulk and seal weather tight per Manufacturer's instructions and Architectural details.
- C. Vibration isolation shall be included as specified above and detailed on the Drawings.

3.16 TEMPERATURE CONTROL:

- A. Division 26 Contractor shall furnish and install control wiring between HVAC units and control thermostats/sensors. **TESTING AND ADJUSTING:**
- B. Test and adjust each piece of equipment and each system as required to assure proper air balance and operation.
 - 1. Test and regulate ventilation and air conditioning systems to conform to the air volumes shown on the design Drawings.
 - 2. Make tests and adjustments in apparatus and ducts for securing the proper volume and face distribution of air for each grille and ceiling outlet.
 - 3. Where required, provide pulleys for fans at no additional cost to the Owner, and set to drive the fan at the speed to give the indicated volume.
 - 4. For each system, take the following data in tabulated form:
 - a. Air volumes at all supply, return, and exhaust outlets
 - b. Total cfm supplied
 - c. Total cfm returned
 - d. Total outdoor air cfm supplied
 - e. Total cfm exhausted
- C. Submit two sets of test and balance reports to the Architect for approval.
- D. Eliminate noise and vibration, and assure proper function of all controls, maintenance of temperature, and operation in accordance with the approved design.

3.17 EQUIPMENT STARTUP SERVICE:

- A. Complete installation and startup checks according to manufacturer's written instructions:
 - 1. Start unit according to manufacturer's written instructions.
 - 2. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 3. Calibrate thermostats and sensors.
 - 4. Inspect dampers for proper stroke and interlock.
 - 5. Inspect controls for correct sequencing of heating, cooling, ventilating, positioning dampers, and normal operation, interlock operation and emergency shutdown.
 - 6. Adjust and test control setpoints.
- B. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension for fans with belt drive.
- C. Prepare written report of the results of startup services for all equipment.
- D. Perform Test and Balance of HVAC systems.

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3.18 INSTRUCTIONS:

- A. Upon completion of this portion of the Work, and prior to its acceptance by the Owner, provide a qualified representative and fully instruct the Owner's maintenance personnel in the proper operation and maintenance of items provided under this Section.

- B. Demonstrate the contents of the approved operation and maintenance manual required in the "Submittals" Section of these Specifications.

END OF SECTION