2. Material Type 2:
   a. Pipe – Black steel, schedule 40 meeting ASTM A120 standards.
   b. Fittings – 150 lb. class black malleable iron meeting ASME B16.3.
   c. Joints – Screwed with tapered threads per ASME B1.20.1 standards with Teflon pipe joint compound applied to male threads only.
3. Material Type 3:
   a. Pipe – Type L hard drawn copper tubing meeting ASTM B88 or ASTM B280.
   b. Fittings – Wrought copper meeting ANSI B16.22.
   c. Joints – Silver brazed with sil-fos or silver solder.
5. Material Type 4:
   a. Pipe – Same as Type 3.
   b. Fittings – Same as Type 3.
   c. Joints – Same as Type 3, except that a solder meeting ASTM B32 may be utilized in a soldered joint suitable for 150 lb. service.
6. Material Type 5:
   a. Pipe – Copper drainage tube DWV meeting ASTM B306.
   b. Fittings – Wrought copper solder-joint drainage fittings meeting ANSI B16.29.
   c. Joints – Soldered with a solder meeting ASTM B32.

D. Underground condenser water system and return piping shall be coated and wrapped in a system equal to "X–TRU–COAT" polyethylene or a factory–applied fibrous mat, coal tar and Kraft paper system. Joints and fittings shall be field–wrapped with a hot applied Tapecoat system. Coating and wrapping shall extend 6" to 12" above finished grade or floor.

E. As a deductive alternate, price a schedule 40 PVC underground CWS&R system. Joints shall be solvent–welded, socket type.

2.02 PIPE HANGERS AND SUPPORTS

A. Pipe hangers, trapeze hangers, upper attachments, rods and other supports shall be selected based on pipe size and material contained therein. Provide all hangers, rods, turnbuckles, angles, channels and other supports to securely support the piping systems from the building structure.

B. All materials utilized for the hanging and support of the piping systems shall be manufactured products which are specifically intended for the purpose of hanging piping systems. The use of wire, steel straps, plastic ties, etc. is strictly prohibited.

C. Supports and hangers shall be selected to fit around the pipe (and insulation unless otherwise specified herein) and provide adequate movement for expansion of the piping system. Anchors shall be provided to restrict and control such movement within offsets and expansion loops.

D. All hangers and supports shall be selected at a minimum factor of safety of five based on the ultimate tensile strength of the material.

E. Intermediate pipe supports shall be provided between building structural members so as not to exceed maximum support spacing specified and shall be structural steel angles (minimum 2 1/2" x 2 1/2" x 1/4"). In steel construction, intermediate supports shall be securely clamped to steel beams and to steel joists, and in no case shall supports be attached to roof decks.

F. For suspending pipes from concrete beams, upper attachments shall be side beam bracket utilizing bolts in sleeves set in top portions of the beams. Where sleeves are not used, provide expansion shields or power–actuated fasteners.

G. Hanger rods for pipe hangers shall be as follows:

HANGER ROD SIZE	NOMINAL PIPE SIZE
3/8"	2" and Smaller
1/2"	2 1/2" and 3"
5/8"	4" and 5"
3/4"	6"
7/8"	8" thru 16"

H. Pipe hangers selected for supporting horizontal insulated piping shall be sized to fit around the outside of the pipe insulation except for the following services, which shall be sized to fit around the pipe and under the insulation:

1. Hot water supply and return piping, steam, condensate return and related piping sized 2" and smaller.

I. Provide pipe saddles, inserts and shields on all insulated piping as outlined below:

1. Hot water supply and return piping and associated steam and condensate return piping over 2" shall be supported by steel saddles welded to pipe. Insulation shall be continuous through the saddle.
2. All other insulated piping shall be supported on Foamglas insulation inserts and galvanized shields, except that no inserts are required on piping sized less than 2". Foamglas inserts shall extend at least 2" past each end of the pipe shields.
   a. Shields shall be as follows:
      a.a. Pipes 2" and smaller: 18 gauge x 12" long.
      a.b. Pipes 2 1/2" and larger: 16 gauge x 18" long.
   b. Shields and inserts shall be 180 degrees around the lower half of the pipe at all pipe hangers, except that on trapeze hangers, pipe racks and floor supported horizontal pipes, shields shall be 360 degrees around the entire pipe.

J. Provide riser clamps at all floor penetrations. Provide vibration isolation at all riser clamps with two (2) pad–type mountings consisting of a minimum 3/8" thick ribbed or waffled elastomeric pads bonded between minimum 16–gauge galvanized steel separator plates. Pads shall be sized for a deflection of 0.12" to 0.16". Pads shall be minimum 3" x 3" square.

2.03 VALVES

A. All valves shall have the manufacturer's name or trademark and the working pressure cast or stamped on the valve body.

B. All valves utilizing packing shall be designed and constructed to allow repacking while under pressure.

C. Gate valves for water services shall be as follows:

1. Non–rising stem type:
   a. Valves 2" and smaller shall be bronze construction screwed bonnet with threaded end connections meeting MSS–SP80. Valves shall be rated for 125 W.S.P., 200 lb. (minimum) W.O.G Stems shall be bronze ASTM B–62 or silicon bronze ASTM B–371 with malleable iron handwheels. Valves shall be Hammond, Milwaukee, Stockham or Nibco.
   b. Valves 2 1/2" and larger shall be iron body with bolted bonnet, inside screw, bronze trim, wedge disc and flanged end connections. Valves shall be rated for 125 W.S.P., 200 lb. (minimum) W.O.G. Meeting MSS–SP70. Valve shall be Hammond, Nibco, Milwaukee or Stockham.
2. Rising stem type:
   a. Valves 2" and smaller shall be bronze construction with screwed bonnet with threaded end connections, wedge disc and screwed end connections Meeting MSS–SP80. Valves shall be rated for 125 W.S.P., 200 lb. (minimum) W.O.G. Stems shall be bronze ASTM B–62 or silicon bronze ASTM B–371 with malleable iron handwheels. Valves shall be Hammond, Stockham, Milwaukee, Nibco.
   b. Valves 2 1/2" and larger shall be iron body with bolted bonnet, outside screw and yoke, bronze trim, wedge disc and flanged end connections. Valves shall be rated for 125 W.S.P., 200 lb. (minimum) W.O.G. meeting MSS–SP70. Valves shall be Hammond, Stockham, Milwaukee or Nibco.

D. Globe valves for water service shall be as follows:

1. Globe valves 2" and smaller shall be bronze with union bonnet, replaceable TFE disc and threaded end connections meeting MSS–SP80. Valves shall be rated for 150 W.S.P., 300 pounds (minimum) W.O.G. Stems shall be bronze ASTM B–62 or silicon bronze ASTM B–371, with malleable iron handwheels. Valves shall be Hammond, Milwaukee, Stockham or Nibco.
2. Valves 2 1/2" and larger shall be iron body with bronze trim, yoke bonnet, solid disc and flanged end connections. Valves shall be rated for 125 W.S.P. 200 pounds (minimum) W.O.G. Valves shall be Hammond, Milwaukee, Stockham or Nibco.

E. Ball Valves 2 inch and smaller for chilled water:

1. Ball valves shall be two piece bronze body, large port with solid, smooth bore chrome plated brass ball, meeting MSS–SP110. Seats shall be reinforced TFE with Teflon packing ring and threaded adjustable packing nut. Valves on insulated lines will be provided with stem extensions to provide clearance for two inches of pipe insulation. Valves to be Apollo 70, Hammond 8501 or Watts B–6000.

F. Butterfly valves for use in chilled and condenser water only shall be as follows:

1. Butterfly valves shall be tapped full lug type designed to hold the valve against the upstream pipe flange independently of the downstream pipe flange meeting MSS–SP67. Valves shall be designed for use in systems with continuous operating temperatures between 40 degrees F. and 120 degrees F. Valves sized 6" and smaller shall be provided with memory–stop manual lever type handles with locking quadrant; valves 8" and larger shall have worm–gear operators with cast or malleable iron handwheels. All valves shall be equipped with position indicator plates. Automatic control valves shall be provided with pneumatic**electric** operators which shall provide full modulation from closed to open and positive closure. Valves shall be 150 lb. (minimum) W.O.G. valves with cast iron body, bronze alloy disc, stainless steel stem, EPDM (EPT) replaceable seat liner and shall have extended neck to allow for insulation in those piping services specified to be insulated. The valve liner design shall be such that it shall serve as a flanged seal and no separate gasket shall be required. Valves shall be Hammond, Mission, Demco, Keystone, Grinnell or Center Line. Butterfly valves shall not be utilized in hot water piping systems.

G. Check valves shall be as follows:

1. Check valves shall be non–slam type with iron body, globe–type silent checks with bronze trim, stainless steel spring and flanged end connections. Flow area through the valve shall exceed the cross sectional area of the pipe in which the valve is installed by not less that 10%. Valves shall be Mueller Steam Specialty Co., APCO, Metra–flex Globe Style Silent Check Valve Hammond IR 9354, or TRW Mission. All check valves on pump discharges shall be non–slam type.

H. Balancing valves:

1. Balancing valves shall have a cast iron body, bronze trim and bronze disc. Valve shall be suitable for 125 psig working pressure and provide positive shut–off. Each balancing valve shall be equipped with two gauge taps with check valves and drip caps. Provide preformed insulation to encase valve assembly. Balancing valves shall be Bell and Gossett Circuit–Setter Plus or equal by Illinois or Armstrong. After the test and balance is complete, provide to the Owner a differential pressure gauge to match the balancing valves.

I. Plug valves shall be as follows:

1. Plug valves shall be semi–steel body with lubricated plug and TFE seals. All valves shall be wrench operated and one wrench shall be provided with each size valve. Each valve shall be provided with the manufacturer's sealant. Plug valves shall be as manufactured by Nordstrom, Powell or Resun.

J. Relief valves shall be sized to have the pressure and temperature relief capacities indicated by their service. Relief valves shall be ASME rated and labeled.

2.04 FLEXIBLE PIPE CONNECTIONS

A. Flexible pipe connections for refrigerant relief piping shall be of flexible stainless steel construction with a minimum length of 12". Inner hose shall be type 320 stainless steel surrounded by an outer braiding of type 321 stainless steel. Hose shall be designed for a minimum working pressure of 125 psi at 250 degrees F.

B. Flexible piping connections for chilled and condenser water service shall be suitable for 150 psi working pressure and shall be fabric–reinforced neoprene, flanged construction with a length not less than their pipe size diameter.

2.05 STRAINERS

A. Strainers shall be Y–type and rated for a minimum working pressure of 125 psi WOG. Strainers sized 2" and smaller shall have screwed end connections and be provided with 20 mesh monel screens. Strainers sized 2 1/2" and larger shall have flanged ends and be provided with 1/16" perforated, 24 gauge stainless steel baskets. All strainers shall be provided with a blow–down connection complete with a full–size gate valve with hose end connection.

B. Strainers shall be manufactured by Metraflex or Mueller.

2.09 THERMOMETERS AND PRESSURE GAUGES

A. Thermometers and pressure gauges shall be products of Trerice, Weksler or Weiss. Select all devices to operate within 20% of the midpoint of their scales under normal operating conditions. Gauges provided on pumps shall be compound type.

2.10 PRESSURE AND TEMPERATURE (P&T) TEST PLUGS

A. Plugs shall be constructed of brass with two (2) self–closing Nordel cores and be complete with cap and gasket.

B. Plugs shall be as manufactured by Peterson or Lancaster.

C. Provide a complete test kit to the Owner at the time of final inspection. Test kit shall be complete with pressure gauge, thermometer, probes and carrying case.

3.0 EXECUTION

3.01 ARRANGEMENT

A. Follow the general piping layout, arrangement, schematics, and details. Provide all offsets, air vents, drains and connections necessary to accomplish the installation. Fabricate piping accurately to measurements established at the project site to avoid interference with ductwork, other piping, equipment, openings, electrical conduits and light fixtures. Make suitable provision for expansion and contraction with expansion loops and offsets.

3.02 MINIMUM HANGER SPACING

A. Pipe hangers or supports shall be provided within 18" of each horizontal fitting, equipment connection, valve, etc. and at not more than the following spacings along horizontal runs of straight, plain piping:

Pipe Size	Maximum Span
1.	2" and smaller 8 ft.
2.	2 1/2" through 4" 12 ft.
3.	5" through 8" 16 ft.
4.	10" through 14" 22 ft.
5.	16" and 18" 26 ft.

B. Riser clamps shall be provided at each floor penetration.

3.03 UNDERGROUND PIPING

A. All underground piping shall have a minimum cover of 3'–0".

B. Provide concrete thrust blocks at all changes of direction and secure all joints.

C. All underground copper water lines shall be protected from corrosion with a continuous plastic sheathing or coating and wrapping. This sheathing or coating and wrapping shall be extended 6" to 12" above finished floor.

3.04 REFRIGERANT PIPING INSTALLATION

A. All refrigerant piping shall be sized in accordance with the air conditioning equipment manufacturer's written instructions. Provide charging ports, solenoid valves, service valves, dryers, etc. at each piece of equipment.

B. All brazing shall be done while the line is being flushed with carbon dioxide, nitrogen or other inert gases.

C. The inside of all tubing shall be thoroughly cleaned and internally wiped with a lintless, dry cloth.

D. Suction lines shall drop below their coils before any horizontal run.

E. Provide oil traps at least every ten feet for extended vertical risers.

F. All oil traps shall be constructed from close–radius type fittings.

G. Dryer cores shall be installed to remove horizontally or downward.

H. Install external equalizer downstream of its expansion valve sensing bulb.

I. Install expansion sensing valve bulb on top centerline of piping up to 5/8" size; install 45 degrees down from the horizontal centerline on pipe sizes 7/8" and larger.

END OF SECTION

SECTION 23181

HVAC PIPING INSULATION

1.0 GENERAL

1.01 DESCRIPTION

A. All work specified in this Section is governed by the HVAC General Section 23010.

B. This Section 23181 and the accompanying drawings cover the provisions of all labor, equipment, appliances and materials, and performing all operations in connection with the construction and installation of the following insulation systems:

1. Hot water supply and return (HWS&R)
2. Refrigerant suction (RS)
3. Condensate drains (COND DR) (indoors only)

C. All insulation products installed indoors shall meet NFPA 90A, 90B and 255 requirements for Flame Spread Rating 25 and Smoke Developed Rating 50.

D. Inserts for all piping which is specified to have hangers outside the insulation shall be provided at such hangers and supports for all piping 2" and larger. Inserts shall be Foamglas insulation, and shall be at least 2" longer than the length of the associated pipe shields.

1.02 INTENT

A. It is the intent of this Section of the specifications to provide a complete piping insulation system which is free of gaps and tears, properly fitted and finished, free of sweating, and fabricated so as to fit the space allotted and to exhibit a negligible heat transfer.

B. The word "piping" is defined to mean all piping, fittings, joints, hangers, coatings, valves, cocks, test and sensor wells and accessories necessary for the HVAC piping systems described, shown and specified.

1.03 ACCEPTABLE MANUFACTURERS

A. Insulation products shall be as manufactured by Owens Corning, Knauf, Manville, Certainteed, Dow or Armstrong.

2.0 PRODUCTS

2.01 PIPING INSULATION

A. Piping insulation installed inside the building, except for the refrigerant suction service, shall be fiberglass preformed pipe insulation with a white all–service jacket/vapor barrier. Insulation shall have a maximum K of 0.23 BTU/in/Hr/SF/deg. F., at a mean temperature of 70 degrees F. For pipe sizes 2" through 4", 1–1/2" thick insulation shall be used; for pipe sizes larger than 4", 2" thick insulation shall be used; and for pipe sizes smaller than 2", 1" thick insulation shall be used.

B. Piping insulation installed outside the building, except for the refrigerant suction service, shall be prefabricated 2 lb./cu.ft. density polyisocyanurate insulation (Trymer 9501 or approved equal) with waterproof mastic and glass fiber jacket finished with an aluminum jacket with waterproof silicone caulk joints. Outside the building, insulation with a maximum K of 0.14 BTU/in/Hr/SF/deg. F. at a mean temperature of 70 degrees F., shall be used. Outdoor piping 4" and smaller shall be insulated with 1" thick insulation; outdoor piping 4" and larger shall be insulated with 1–1/2" thick insulation.

C. Closed–cell insulation shall be provided over all refrigerant suction piping and other services as specified or noted. Closed–cell piping insulation shall be 1/2" thick 25/50 Armaflex or Rubatex. All glues and coatings shall be products of the same manufacturer as the insulation.

D. Insulation shall be continuous over all valve bodies, fittings, and wall and floor penetrations. Do not insulate unions on hot water piping; nor instruments, gauges, valve handwheels, etc. on any piping.

E. All piping insulation covering water–carrying piping which is exposed to the weather and subject to bursting from freezing temperatures shall have oversized insulation to accommodate heating cable.

F. Provide a continuous water–tight aluminum jacket and fitting covers for all polyisocyanurate insulation piping exposed to the weather.

3.0 EXECUTION

3.01 INSTALLATION OF PREFORMED PIPE INSULATION

A. Indoors
   1. Preformed pipe insulation with all–service jackets shall have all longitudinal joints lapped by a minimum of 2" and sealed with fire retardant adhesive. Butt joints shall be sealed with 3" wide tape similar to the insulation vapor–barrier jacket and secured with adhesive.
   2. All elbows shall be insulated with preformed fitted insulation equal to the thickness specified for the adjacent piping insulation. As an alternative, provide fitting covers meeting NFPA/UL 25/50 ratings; stuff all covers with fiberglass insulation having characteristics equal to adjacent pipe insulation.
B. Outdoors
   1. Preformed pipe insulation for exterior water–carrying pipe shall have insulation secured on with copper wire with ends twisted and turned into the insulation. Over the insulation, apply mastic to a minimum 1/4" thickness and draw in, while mastic is wet, glass fiber cloth. Finish with aluminum jacket with waterproof silicone caulk joints.
   2. All water–carrying piping subject to freezing weather shall have self–regulating electric heat tracing installed as specified in Section 15190.

3.02 CLOSED–CELL PIPING INSULATION INSTALLATION

A. Insulation shall be provided on all refrigerant suction and condensate drain lines. The insulation shall be installed by the slip–on method; slitting of the insulation is prohibited and shall be cause for rejection. All elbows shall be mitered and all such joints and butt joints shall be tightly made and glued.

B. All insulation installed outdoors shall be coated with a glossy white, ultraviolet protective coating applied in two coats.

3.03 MISCELLANEOUS REQUIREMENTS

A. Where insulation is installed over pipe hangers, seal vapor barrier at all penetrations. Also seal all end joints at unions and points of termination by bevel cutting the end and drawing jacket over until secured at the pipe. Apply white mastic to all end seals over jacket.

END OF SECTION

SECTION 23740

TERMINAL UNITS

1.0 GENERAL

1.01 DESCRIPTION

A. All work specified in this section is governed by the HVAC General Section 23010.

B. This Section 23740 and the accompanying drawings cover the provisions of all labor, equipment, appliances and materials, and performing all operations in connection with the construction and installation of the terminal units as specified herein and as shown. These units include, but are not limited to the following:

1. Variable air volume (VAV) units
2. Powered induction units (PIU)
3. Associated control systems

1.02 INTENT

A. It is the intent of this Section of the specifications to provide complete, operable, adjusted terminal units as shown and specified which are free of excessive noise, vibration and airflow fluctuations.

1.03 BASIS OF DESIGN

A. The basis of design is Titus. Any proposed substitutions shall be proven equal in all aspects to the equipment specified as the basis of design.

1.04 ACCEPTABLE SUBSTITUTE MANUFACTURERS

A. Acceptable substitute manufacturers are Trane, Metalaire, Price, Carrier, Nailor and Reddi.

2.0 PRODUCTS

2.01 DESCRIPTION

A. Variable air volume units (VAV) shall consist of primary air damper, attenuator section and noise shroud (if required to meet listed sound pressure levels), primary air damper actuator, primary air controller and any other items required to perform as indicated and specified.

B. The maximum acceptable NC at the VAV unit discharge is 40 at 1.0" inlet static pressure; the maximum acceptable radiated NC is 40 at 1.0" inlet static pressure. The maximum static pressure drop through the unit shall be 0.45" W.C. The maximum inlet velocity shall be 2200 FPM. The NC levels shall be rated with an 8dB total ceiling and room effect and 5'–0" of lined ductwork downstream of the unit.

C. The unit housing shall be constructed of galvanized steel sheets, reinforced to eliminate excessive flexing. Housing shall be internally lined with acoustical fibrous glass liner conforming to NFPA requirements. Service to internal parts shall be through an access door in the bottom or side of the housing.

D. Controls shall be low–voltage electronic type with electrical actuators.

E. A pressure independent primary air volume controller shall control the supply air quantity within 5% of the air volume required to satisfy the thermostat, regardless of changes in system static pressure. Each unit shall be factory set for maximum and minimum CFM. The VAV valves shall be normally closed on a loss of control power.

F. Powered induction units (PIU's) shall be factory fabricated complete with variable air volume section, fan powered induction section, disposable filter, backdraft damper for fan section, acoustically lined plenum section, factory–mounted heating coil (installed downstream of the fan section) and all electrical contactors, P.E. switches and controls. PIU shall have variable air volume unit (VAV) for primary air with fan discharge perpendicular to the VAV unit. See Paragraphs 2.01 A through E for VAV units.

G. Intermittent operation fan powered induction section shall consist of:

1. An acoustically lined sheetmetal housing and centrifugal direct drive fan wheel.
2. Resiliently mounted, vibration–isolated, permanently lubricated, 3–speed PSC fan motor of the voltage shown on the electrical drawings.
3. Backdraft damper to prevent reverse flow through blower.

I. The plenum section shall be acoustically lined and shall receive air from either the primary VAV unit or the induction fan, and distribute the air through the low pressure duct system. Parallel (side by side) discharge is unacceptable.

J. Each PIU, when operating in the fan powered, 100% induced air mode, shall be capable to operate against a minimum external static pressure of 0.35" with a maximum NC level of 35 at the discharge. At the same operating condition, the radiated noise shall be a maximum NC level of 35. All NC ratings are based on an 8dB total ceiling and room effect and 5'–0" of lined ductwork downstream of the unit. The PIU shall produce the indicated capacity with the fan motor in low or medium speed. High speed selection is not acceptable.

K. The PIUs shall have intermittent fan operation except those serving toilets, lobbies and other core areas, which shall be constant volume units.

L. There shall be only one electrical power connection required to each PIU assembly to provide electrical power to both the fan and the electric heater. Unit shall operate on 277–volt, 1–phase. Provide a separate fused disconnect and wiring for the fan motor. The fan motor shall draw not more than 4 amperes at high speed when connected to 277 volts, single phase. Coordinate which phase the motor is to be connected to (A, B, or C) with the electrical drawings.

2.03 HOT WATER HEATER COILS

A. Hot water heating coils shall be constructed of copper tubing with aluminum fins mechanically bonded to the tubing. Coils shall be suitable for 150 psi working pressure and factory leak tested at a minimum of 300 psi.

3.0 EXECUTION

3.01 INSTALLATION

A. Units shall be installed as indicated and in conformance with the manufacturer's recommendations. Coordinate the actual units to be provided with all trades.

3.02 ADJUSTMENT

A. The units shall be tested and adjusted after installation to provide the capacities indicated.

END OF SECTION

SECTION 23800

AIR DISTRIBUTION DEVICES

1.0 GENERAL

1.01 DESCRIPTION

A. All work specified in this section is governed by the Mechanical General Section 23010.

B. This Section 23800 and the accompanying drawings cover the provisions of all labor, equipment, appliances and materials, and performing all operations in connection with the construction and installation of air distribution devices as specified herein and as shown. These units include, but are not limited to the following:

1. Ceiling Diffusers (CD)
2. Return Air Grilles (RAG)
3. Exhaust Registers (ER)
4. Slot Diffusers (SD)
5. Linear Slot Diffusers (LSD)

1.02 INTENT

A. It is the intent of this Section of the specifications to provide complete, operable, adjusted air distribution devices as shown and specified which are free of excessive noise, vibration and airflow fluctuations.

1.03 SELECTION CRITERIA

A. All air distribution devices shall be selected in accordance with the following minimum criteria unless otherwise noted below or on the drawings:

1. Method of mounting shall be compatible with the ceiling, wall or duct surface which it mounts on or in; i.e. lay–in, surface mounting, plaster frame, duct collar, etc. The architectural drawings shall be referenced to determine the mounting method for each device. All flanges on surface mounted devices shall be provided with a gasket.
2. Finish of all ceiling mounted devices shall be selected to match the color of the adjacent ceiling. Finish of all wall mounted devices shall be primer which is compatible with the finish coating specified for the adjacent wall; finish coat will be applied under Division 9.

1.04 BASIS OF DESIGN

A. The basis of design is Nailor. Any proposed substitutions shall be proven equal in all respects to the equipment specified as the basis of design. Any modifications to ductwork, controls, ceilings, building structure, etc., that result from any substitution shall be coordinated with all trades. This coordination shall occur before delivery of equipment and any modifications shall be performed without incurring additions to the Contract.

1.05 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are Price, Carnes, Metal Aire and Titus, provided that their units, performance, appearance and physical characteristics are equal in all respects for this specific project.

2.0 GENERAL

2.01 DESCRIPTION

A. Ceiling Diffuser (CD)
   1. Ceiling diffusers shall be plaque face diffusers equipped with fully adjustable pattern controls, capable of providing one–way, two–way, two–way corner, three–way, and four–way air patterns; Nailor Uni2. Diffuser performance data shall be in accordance with ADC equipment test code 1062R4. The perforated face shall be hinged for easy access to pattern controls and duct accessories. The maximum NC level at design airflow shall not exceed 35 when measured in a direct field 5'–0" from the face of the device.

B. Return Air Grilles (RAG)
   1. Return air grilles shall be plaque face, lay–in type, selected to match the CDs; Nailor Uni2 except the neck shall be 15" round. Performance data shall be in accordance with ADC 1062R4. All other characteristics shall be equal to the ceiling diffusers.

C. Exhaust Registers (ER)
   1. Exhaust registers shall be surface mounted, fixed curved blade steel registers with blades at 0.666 to 0.750 inches on center. Provide opposed blade dampers with each ER for balancing purposes. ERs shall be Nailor 5100 series sized as indicated.

D. Slot Diffuser
   1. Supply (SD)
      a. Each slot diffuser shall be equipped with an individually adjustable pattern controller for each slot to insure full 180 degree air pattern; Nailor 5700 series. The diffuser shall be constructed of 24 gauge galvanized steel with inlet size and length as indicated. Each SD shall be provided with a lined steel plenum with tappings for round duct connections as indicated. Maximum NC level shall not exceed 35 at design airflow. Liner shall conform to NFPA 90A 25/50 requirements.
   2. Return (RS)
      a. Return slots shall meet all above requirements for slot diffuser with the exception that the pattern controllers shall be removed to allow maximum free area for return air flow. Nailor 5700 series.

E. Linear Slot Diffuser (LSD)
   1. Supply (LSD)
      a. Linear slot diffusers shall be Titus FlowBar. Diffusers shall be of aluminum construction with one or more parallel slot(s). Each slot shall contain pattern controls, adjustable from the face of the diffuser. The same pattern controls shall function as volume controls without affecting the air discharge pattern. Each LSD shall be continuous length as indicated on the Drawings, complete with finished ends, mitered corners and splined joints. Plenums shall also be provided as indicated with all open inactive sections of the LSD covered with blank–off internal plates. Plenums shall have round collars for connection of flexible duct. Performance data shall be per ADC with a maximum NC of 35.

3.0 EXECUTION

3.01 INSTALLATION

A. Air distribution devices shall be installed as indicated and in conformance with the manufacturer's recommendations. The color, frame and border types shall be coordinated with Architectural requirements and shall be selected to install in the finished surface indicated.

3.02 ADJUSTMENT

A. Grilles, registers and diffusers shall be tested and adjusted to provide the scheduled air flow capacities.

B. All adjustable air distribution devices located within three feet of any wall shall be set to blow directly away from, or parallel to, the wall.

C. In all slot diffuser applications, the inactive sections of the slot shall be finished with perforated steel, painted flat black, selected to match the CDs. These sections shall be open to the plenum as a return air path.

END OF SECTION

SECTION 23840

DUCTWORK

1.0 GENERAL

1.01 DESCRIPTION

A. All work specified in this Section is governed by the HVAC General Section 23010.

B. This Section 23840 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the ductwork systems as specified herein and as shown. These systems include, but are not limited to, the following:

1. Supply air ductwork
2. Return, transfer and relief air ductwork
3. Exhaust ductwork

1.02 INTENT

A. It is the intent of this Section of the specifications to provide a complete operable duct system as shown and specified which is reasonably airtight, free of noise, vibration and sweating, and fabricated so as to fit into the space allotted and to exhibit a minimum resistance to airflow.

1.03 DESIGN AND CONSTRUCTION

A. Ductwork shall be provided in strict accordance with the first edition – 1985 – of the SMACNA HVAC Duct Construction Standards – Metal and Flexible, NFPA No. 90A, 90B, 91 and 96, and UL 181.

B. Ductwork dimensions shown are net, clear, inside dimensions with no allowance shown for duct liner. All ductwork specified to be lined shall be 2" larger than shown in each dimension to compensate for the liner. Ductwork shall be square, rectangular, round, spiral or flat oval as noted. Conversion of duct shapes and sizes shown shall be accomplished without increasing air velocities or friction losses and is subject to prior approval by the Architect.

C. Elbows shall be either full radius type (inside radius equal to duct width), five–gore radiused flat–oval type or, in low pressure systems only, mitered with double–thickness turning vanes.

D. Abrupt changes in duct sizes and shapes shall not be permitted. The total angle of diverging transitions shall be not more than 15 degrees; converging transitions shall be not more than 30 degrees unless otherwise noted or required due to structural constraints.

E. Offsets, transitions, rises and drops are not individually called out on the design drawings. They shall be provided as required to fit the ductwork into the allocated spaces.

F. Transition rectangular ductwork on bottom and sides. Maintain top of ductwork level and as high as possible.

G. All supply air ductwork between the VAV self–contained air handling unit and the terminal units shall be constructed for 3" WC static pressure class at 4000 FPM velocity with Class A seals and is herein defined as "medium–pressure" ductwork. All other ductwork shall be constructed for standard 1" WC static pressure class at 2500 FPM with Class C seals and is herein defined as "low pressure ductwork."

H. Provide the following types of ductwork material for the services indicated:

TYPE OF MATERIAL	SERVICE
1. Galvanized sheetmetal conditioned	Supply, return, exhaust and relief of comfort and outside air.

2.0 PRODUCTS

2.01 GALVANIZED SHEETMETAL

A. Galvanized sheetmetal shall be lock–forming grade G90–ASTM A 525 hot dip galvanized steel sheets. Sheetmetal shall be galvanized on each side with not less than 1.25 ounces of zinc per square foot.

2.02 SPIRAL DUCT

A. Spiral duct shall be utilized for all flat–oval and round ductwork in medium and high–pressure systems.

B. Spiral duct shall be the product of United McGill Corporation, R.V. Money or an approved equal.

C. Spiral ribbed duct that reduces the metal thickness is not acceptable.

2.06 DAMPERS

A. Manual Volume Dampers
   1. Single blade butterfly dampers are acceptable up to 12" round or 12" x 12" square. Dampers larger than these dimensions shall be multi–blade type. Single blade dampers shall be constructed of 16 gauge or heavier galvanized sheetmetal.
   2. No multi–blade damper blade shall exceed 8" in width. All multiple blade dampers shall be constructed of 16 gauge galvanized steel or heavier. The damper frame shall be 16 gauge or heavier. The damper action shall be opposed–blade type.
   3. Each blade shall pivot on a 1/2" cadmium plated, cold–rolled steel axle which pivots within self–lubricating, oilite bronze bearings.
   4. The top and bottom edges of each rectangular damper blade shall be crimped for stiffness.
   5. The operating rod for all dampers shall be extended outside the damper frame for attachment of an operator. Each operator shall have a position indicator and locking quadrant.
   6. All dampers utilized for introduction of outside air shall have flexible, gasketed edge and end seals. The leakage rate shall be less than 4 CFM per sq. ft. of face area against a 1" W.G. differential pressure, based on a nominal 48" x 48" damper size.
   7. Manual volume dampers shall be as manufactured by Louvers & Dampers, Inc. or an approved equal.
B. Control Dampers
   1. Control dampers shall be of the same construction as manual volume dampers, except that no manual operator and quadrant is required. The operating rod shall be suitable for operation by an automatic pneumatic or electric operator.
C. Fire Dampers
   1. Fire dampers shall be UL–listed and labelled for 1 1/2 hours and shall be provided with 160 degrees F. links. Dampers installed within ducts shall be Type B or Type C with the blades out of the airstream. Areas indicated shall be net, clear, open areas.
D. Smoke Dampers
   1. Smoke dampers shall be UL–listed as Class 1 low–leakage smoke dampers and shall be products of Prefco.

2.07 LOW–PRESSURE DUCT BRANCHES

A. Splitter dampers shall be provided at all low–pressure ductwork branches. All low–pressure ductwork branches shall be radiused or 45 degree take–offs; straight taps are unacceptable. The length of the damper blade shall be the same as the width of the widest duct section at the split, but in no case shall blade length be less than 12". Each operator rod shall have a locking swivel joint.

2.08 FLEXIBLE DUCT

A. Flexible ductwork shall be Class 1, UL 181 air duct and meet NFPA 90A and 90B Standards.

B. The internal duct surface shall be acoustically rated, black CPE bonded to a coated steel wire helix. The external jacket shall be a fiberglass, bi–directionally reinforced, metallized vapor barrier with a standing, triple ply seam. Fiberglass insulation shall be provided between the duct surface and the jacket to achieve a maximum thermal conductance of 0.23 BTU/Hr./sq. ft./degree F. at 75 degrees F. mean.

C. Flexible ductwork shall be suitable for 10" W.G. positive pressure and 1" W.G. negative pressure.

D. Flexible ductwork, insulation and insulation cover shall be suitable for ceiling return air plenum installation and shall comply with all applicable codes and standards regarding such ceiling plenum installations.

E. Flexible duct shall be Thermaflex M–KE or an approved equal.

F. The maximum allowable installed length of flexible ductwork shall be as follows:

1. 8'–0" on low–pressure supply air systems limited to short runouts and end of runs connected to round neck supply diffusers and registers.
2. 4'–0" on medium and high–pressure supply air systems limited to the runouts from the sheetmetal ductwork to each terminal unit.
3. 2'–0" on connections from round neck grilles to sheetmetal ductwork on return, exhaust and transfer ductwork.

G. Provide a spin–in fitting with integral scoop and volume damper at all flexible run–out connections in low–pressure supply air ductwork only.

2.09 TERMINAL UNIT RUNOUTS

A. Medium and high–pressure runouts to terminal units shall be connected to the trunk duct with factory–welded laterals, conical tees or bellmouth fittings; abrupt round to rectangular taps are strictly prohibited and shall be rejected.

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	12.15.2017	ISSUE FOR PERMIT AND CONSTRUCTION

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STATE OF MAINE BRAD J. RABINOWITZ No. 15176 LICENSED PROFESSIONAL ENGINEER 12/14/17

Project Name

Unum Workplace Transformation - Phase 2 & 3 (HO2 & HO3)

Project Number

59.6481.003

Description

SPECIFICATIONS - HVAC

Scale

M0.002