PROJECT MANUAL

PROJECT NUMBER: 0262-461-2

Clayton B. Wire HVAC

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

February 28, 2023

SECTION 22 10 00

PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.

2. Valves.

3. Domestic water piping specialties.

4. Gas piping specialties.

5. Drain and waste piping specialties.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.3 ACTION SUBMITTALS

A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

B. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing piping systems materials and products.

1.4 INFORMATIONAL SUBMITTALS

A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

B. Provide welding certificate for all gas pipe welders.

C. Gas Pipe Installer Qualifications: Provide evidence of current qualifications for individuals performing work requiring qualifications.

1.5 CLOSEOUT SUBMITTALS

A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

B. Maintenance Data: Submit maintenance data and parts lists for plumbing piping systems materials and products. Include this data in Operation and Maintenance Manual.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

1.7 QUALITY ASSURANCE

A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

B. Gas Pipe Installer Qualifications: Individuals performing tasks requiring qualifications under Federal and State regulations shall be qualified by the gas utility supplying Project site. The qualifications shall be current at the time of performing the Work.

C. NFPA/ANSI Compliance: Fabricate and install natural gas systems in accordance with latest edition of NFPA 54/ANSI Z223.1 "National Fuel Gas Code."

D. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

E. Fabricate and install natural gas systems in accordance with California Plumbing Code.

F. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company requirements.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with California Plumbing Code. Where more than one type of material or product is indicated, selection from materials or products specified is Contractor's option.

B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."

2.2 PIPE AND FITTINGS ATTACHED TO AND BELOW BUILDINGS INCLUDING 5 FEET FROM BUILDINGS

A. Piping and fittings attached to covered walkways and corridors shall comply with the requirements of this article.

B. Drain and Waste Pipe Above Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard (CISPI) 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor’s option, vertical piping above floor from lavatories, sinks, and drinking fountains may be Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV weld pipe and fittings.

1. Joints above grade: No-Hub pipe conforming to ASTM A888 and CISPI 301. Couplings conforming to ASTM 1277 and CISPI 310, with stainless steel bands. Provide products by ANACO-Husky, Tyler, Ideal or equal. Provide sway brace at 20'-0" maximum spacing for suspended pipe with No-Hub joints. Provide a brace on each side of a change in direction of 90 degrees or more. Brace riser joints at each floor and at 15 foot maximum intervals (also see Specification Section 22 00 50).

C. Drain and Waste Pipe Below Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and CISPI 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor’s option, hub and spigot cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A-74 and so marked, may be used.

1. Joints below grade: ANACO-Husky SD 4000, Clamp-All 125, or equal couplings and No-Hub fittings, meeting the requirements of FM 1680, SD Class I and ASTM C1540.

2. Joints below grade (hub and spigot option): Neoprene gaskets conforming to ASTM C564, as manufactured by Ty-Seal, Dual-Tite, or equal.

D. Vent Pipe:

1. 3 inch and larger: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Joints in cast iron vent pipe shall be the same as specified for cast iron waste pipe above grade.

2. 2-1/2 inch and smaller: Cast iron soil pipe and fittings as specified for sizes 3 inch and larger, Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV copper pipe and fittings.

3. Vent pipe buried in ground and to 6 inches above ground: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Joints in cast iron vent pipe shall be the same as specified for cast iron waste pipe below ground.

E. Type DWV copper tubing or No-Hub cast iron pipe and fittings may be used for concealed rainwater leaders. Where no-hub piping is used, the fittings and couplings shall match those used for waste piping.

F. Grease Waste (GW) and Vent (GV) Pipe Underground to 6 Inches Aboveground: George Fisher Sloane, Inc., “Fuseal PP,” Orion Fittings, Inc., “Rionfuse CF,” IPEX, Inc., “Enfield,” or equal, Schedule 40 polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.

G. Grease Waste (GW) and Vent (GV) Pipe Aboveground:

1. In inaccessible spaces or within walls, George Fisher Sloane, Inc., “Fuseal PP,” Orion Fittings, Inc., “Rionfuse CF,” IPEX, Inc., “Enfield,” or equal, flame-retardant schedule 40 polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.

2. In accessible areas: George Fisher Sloan, Inc. “Fuseal PP,” Orion Fittings, Inc. “Blueline,” IPEX, Inc. "Labline," or equal, flame retardant Schedule 40 polypropylene drainage pipe and fittings, with mechanical joints. Piping shall comply with ASTM F1412.

3. Vent pipe aboveground: 3 Inches and Larger: Service weight cast iron soil pipe and fittings; 2-1/2 inches and smaller: Schedule 40 galvanized steel pipe with black cast iron drainage fittings.

H. Acid Waste (AW) and Vent (AV) Pipe Underground to 6 Inches Aboveground: George Fisher Sloane, Inc., “Fuseal PP,” Orion Fittings, Inc., “Rionfuse CF,” IPEX, Inc., “Enfield,” or equal, Schedule 40 polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.

I. Acid Waste (AW) and Vent (AV) Pipe Aboveground:

1. In inaccessible spaces or within walls, George Fisher Sloane, Inc., “Fuseal PP,” Orion Fittings, Inc., “Rionfuse CF,” IPEX, Inc., “Enfield,” or equal, flame-retardant Schedule 40 polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.

2. In accessible areas: George Fisher Sloan, Inc. “Fuseal PP,” Orion Fittings, Inc. “Blueline,” IPEX, Inc. "Labline," or equal, flame retardant Schedule 40 polypropylene drainage pipe and fittings, with mechanical joints. Piping shall comply with ASTM F1412.

J. Water Pipe (Tempered Water, Tempered Water Return, Hot Water, Hot Water Return and Cold Water): ASTM B88, Type L copper tubing, hard-temper, with wrought copper fittings. Provide full solder cup for all fittings. Capped or plugged outlets shall be Schedule 40 screwed brass. Water piping below slab: ASTM B88, Type K copper tubing, hard temper, with wrought copper fittings. At Contractor’s option, pipe runs below slab having no branches may be ASTM B88, Type K annealed copper tubing without joints. See Section 22 00 50 for pipe protection requirements for below slab copper piping.

K. Temperature and Pressure Relief Valve Piping: ASTM B88, Type L copper tubing, hard-temper, with wrought copper fittings. Provide full solder cup for all fittings. Capped or plugged outlets shall be Schedule 40 screwed brass.

L. Gas Pipe: Schedule 40 black steel conforming to ASTM A53, with malleable iron threaded fittings above grade for piping 2 inch and smaller; welded piping below grade and for above grade piping larger than 2 inches, with Class 150 welding fittings.

1. Appliance Flexible Connectors for Indoor Equipment Without External Spring Isolation:

a. Contractor may choose one of the following:

1) Direct gas pipe connection.

2) Appliance flexible connector:

a) Comply with ANSI Z21.24.

b) Polymer or hot-dipped PVC coated corrugated 304 stainless steel.

c) Operating-Pressure Rating: 0.5 psig.

d) End Fittings: Zinc-coated steel.

e) Maximum Length: 30 inches.

f) Manufacturers: Dormont, Series 30C, 31, 40C, 41, and 51, Brasscraft model ProCoat, or equal.

b. Provide with end connections compatible with equipment and piping system.

c. Equipment located in spaces normally accessible to building occupants, other than maintenance personnel, shall utilize direct gas pipe connection.

d. Provide anti-microbial PVC coating for use with appliances located in kitchen areas.

2. Flexible Gas Connector for Outdoor Equipment Without External Spring Isolation:

a. Contractor may choose one of the following:

1) Direct gas pipe connection.

2) Corrugated stainless steel hose with 304 stainless steel braid covering, CSA certified. Metraflex model GASCT, Unisource Manufacturing series 400, or equal. Provide with end connections compatible with equipment and piping system.

3. Flexible Gas Connector for Equipment with External Spring Isolation, Indoors and Outdoors:

a. Where Drawings indicate installation of mechanical equipment on spring isolation rails spring mounted curbs, or spring hangers, provide metal flexible connectors, Metraflex Metraloop, or equal by Unisource Mfg. Co., or Flexicraft Industries, CSA certified for 4 inches of movement in all directions.

4. Flexible Gas Connection System for Movable Gas-Fired Cooking Equipment:

a. System shall include flexible PVC coated braided stainless steel hose, quick disconnect fitting, full port CSA certified ball valve, 2 swivel elbows, coiled steel restraining cable and mounting hardware. Assembly shall be certified per ANSI Z21.69/CSA 6.16, “Connectors

for Movable Gas Appliances." Size as required for appliance connection, 48" minimum hose length. Install per manufacturer's instructions. Connectors shall be Dormont Safety System, T&S Safe-T-Link, or equal.

M. Compressed Air Pipe: Type K copper tubing, hard temper, with wrought copper fittings. Capped or plugged outlets shall be screwed brass.

N. Condensate Drain Piping:

1. Inside buildings provide ASTM B88, Type L copper tubing and fittings. Provide Wye fittings with capped cleanout plug for tubing up to 1 inch size. Provide wrought or cast DWV fittings for sizes 1-1/4 inch and larger.

2. Outside buildings provide ASTM B88, Type L copper pipe and fittings, cast iron drain pipe and fittings or Schedule 40 galvanized steel pipe and cast iron drain or vent fittings.

3. Connect condensate drains to mechanical equipment per equipment manufacturer's recommendations; provide P-trap where required. Slope piping to drain, with 1 inch in 10 foot minimum pitch. Provide di-electric couplings or unions at connections to dissimilar materials.

4. Where Drawings indicate installation of mechanical equipment on spring isolation rails spring mounted curbs, or spring hangers, provide threaded metal connector at mechanical equipment, Metraflex Model SST, or equal by Unisource Mfg. Co., or Flexicraft Industries. Arrange flexible connection to ensure drainage of condensate, and support flexible connection at each end of connector, to ensure proper alignment.

5. Where condensate drain P-traps are required, install trap using Wye fitting on inlet and outlet of trap. Provide cap on top of each Wye, made removable for cleaning and inspection. Drill 1/8 inch diameter hole in cap at outlet of the trap to allow venting of the system. Minimum depth of trap should be 4 inches, or as recommended by the manufacturer in printed literature.

6. Provide cleanout tees or "Y" at each change in direction.

O. Condensing-Type Equipment Condensate Drain Pipe: CPVC pipe and fittings conforming to ASTM D-2846.

1. Provide CPVC condensate drain pipe for condensing water heaters, furnaces, and where shown on Drawings.

2. Piping and fittings shall be as manufactured by Spears Manufacturing, Charlotte Pipe and foundry Co., or equal.

P. Deionized Water Piping:

1. Polyvinylidene Fluoride (PVDF) Pressure Rated Pipe and Fittings: Schedule 80 PVDF pressure rated pipe and fittings. Pipe and fittings shall meet ASTM D-1785. Threaded fittings shall comply with ASTM D-2464. The pipe and fittings shall be sterilized and capped or packaged immediately after production and all seals shall be intact when the material is delivered to the jobsite.

2. Provide continuous channel support under all horizontal piping, B-line, Grinnell, or equal PVC coated channel systems, series B11 through B72 with matching pipe clamps as appropriate, or equal.

2.3 SITE PIPING AND FITTINGS TO 5 FEET FROM BUILDINGS

A. Buried Drain, Waste, and Vent Piping:

1. Install piping from street connection to the property line in accordance with local requirements.

2. 4 inches and larger: PVC, ASTM D3034 - SDR 35; use matching Ring Tite fittings.

3. 3 inches and smaller: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler pipe, or equal. Provide ANACO-Husky SD 4000, Clamp-All 125, or equal couplings and No-Hub fittings, meeting the requirements of FM 1680, SD Class I and ASTM C1540. Pipe and fittings shall be the product of a single manufacturer.

B. Grease Waste (GW) and Vent (GV) Pipe: George Fisher Sloane, Inc., “Fuseal PP,” Orion Fittings, Inc., “Rionfuse CF,” IPEX, Inc, “Enfield,” or equal, polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.

C. Acid Waste (AW) and Vent (AV) Pipe: George Fisher Sloane, Inc., “Fuseal,” Orion Fittings, Inc., “Rionfuse CF,” IPEX, Inc., “Enfield,” or equal, polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.

D. Water Service Piping:

1. Sizes 2 inches and larger (not under building): Gasket style PVC conforming to ASTM D2241-SDR21, Class 200 with gasket type fittings or ductile iron mechanical joint couplings. Gasket fittings shall be one piece injection molded PVC fittings, equal to Flo-Seal water main fittings for PVC pressure pipe, 200 psi, ASTM D-3139.

2. Sizes less than 2 inches: Type K copper tubing, hard temper, with wrought copper fittings. See Section 22 00 50 for pipe protection requirements for below grade copper piping.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. J.M. Eagle.

b. P.W. Pipe.

c. Ipex Series Pipe.

E. Water Service Piping Above Grade:

1. Sizes 3 inches and larger: Class 150 flanged ductile cast iron water pipe conforming to AWWA/ANSI C150/A21.50 and manufactured in accordance with AWWA/ANSI C151/A21.51. Fittings shall conform to AWWA/AWWA C110/A21.10, Class 250 pattern. Pipe and fittings shall have factory applied cement-mortar lining in accordance with AWWA/ANSI C104/A21.4. Flanges shall conform to ASME/ANSI B16.1.

2. Piping 2-1/2 inches and smaller: Type K copper tubing, hard temper, with brazed wrought copper fittings.

F. Gas Piping Underground: Performance Pipe, “DriscoPlex” 6500 PE 2708 (yellow), Polypipe, Inc., “Polypipe”, or equal, polyethylene gas distribution pipe, ASTM D2513, ASTM D3261, and ASTM D2683 fittings with fusion welded joints. Provide piping labeled for natural gas in accordance with CPC.

1. Electrically isolate underground ferrous gas piping from the rest of the gas system with listed or approved isolation fittings installed a minimum of six inches above grade.

2. Provide Central Plastics Corp., Perfection, or equal, anodeless, single seal riser for transition from below grade polyethylene to schedule 40 steel piping above grade. Minimum horizontal

length shall be 30 inches. Minimum vertical length shall be 30 inches, or greater as required. Provide fusion connection to polyethylene pipe below grade, and screwed connection to steel pipe above grade.

G. Gas Piping Aboveground to 30 inches Belowground: Schedule 40 black steel with beveled ends for welding, with Class 150 welding fittings. Mitering to form elbows or tees will not be permitted; where branch tee connections of welded piping are required, Bonney "Weldolet" Allied Pipe Fittings, or equal fittings may be used if the branch is one-half of the diameter of the main or less.

H. Drainage Pipe, Perforated or Un-perforated: J-M PVC, P.W. Pipe, or equal drainage pipe and fittings or non-reinforced concrete sewer pipe ASTM C14.

2.4 FIRE PROTECTION PIPING

A. Refer to specification Section 21 10 00 “Fire Protection.”

2.5 PIPE JOINING MATERIALS

A. Refer to piping Articles in this Section for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated

a. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.

2. AWWA C111, rubber, flat face, 1/8-inch (3.2mm) thick, unless otherwise indicated; and full-face or ring type, unless other indicated.

3. Flange Bolts and Nuts: AWWA C111, carbon steel, unless otherwise indicated.

4. Plastic, Pipe-Flange Gasket, Bolts and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, 100 percent lead free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.

E. Welding Filler Metals: Comply with ASME B31.1 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Solvent Cements for Joining CPVC Piping: ASTM F 493.

1. CPVC solvent cement shall have VOC content of 490 g/L or less.

2. Adhesive primer shall have VOC content of 550 g/L or less.

3. Solvent cement and adhesive primer shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

1. PVC solvent cement shall have VOC content of 510 g/L or less.

2. Adhesive primer shall have VOC content of 550 g/L or less.

3. Solvent cement and adhesive primer shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

2.6 VALVES AND FITTINGS FOR POTABLE WATER SYSTEMS

A. General:

1. Provide valves and fittings conforming to lead-free requirements of California Health and Safety Code Section 116875.

a. Provide valves listed to NSF/ANSI 61-G or NSF/ANSI 372 for valve materials for potable-water service.

1) Exception: Main distribution gate valves above 1-1/2 inches located underground outside building are not required to conform lead-free requirements of California Health and Safety Code Section 116875.

B. Gate Valves:

1. General: Furnish valves in copper lines with adapters to suit valve/line requirements.

2. 1-1/2 inches and smaller: Minimum 200 psi CWP, bronze body, threaded bonnet, rising or non-rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Milwaukee UP148, UP149, Nibco T-113-LF, S-113-LF, or equal.

3. 2 inches through 3 inches: Minimum 200 psi CWP, bronze body, threaded bonnet, non-rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Nibco T-113-LF, S-113-LF, or equal.

4. Main distribution gate valves underground outside building above 1-1/2 inches:

a. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.

1) Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.

2) Furnish and deliver to Owner one wrench of each size required for operating underground valves.

C. Ball Valves:

1. 2 inches and smaller: 600 psi CWP, cast bronze or brass body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T-685-80-LF, Milwaukee UPBA400, Apollo 77C-LF10, Kitz 868, or equal.

2. 2-1/2 inches: Apollo 77C-LF10, or equal.

D. Swing Check Valves:

1. Minimum 200 psi CWP, bronze or brass body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Milwaukee UP509, Nibco T-413LF, Kitz 822T, or equal.

E. Butterfly Valves:

1. General: Tight closing, full lug type, with resilient seat suitable for minimum working pressure of 200 psig, conforming to MSS SP-67. Bi-direction dead end service with downstream flange removed.

2. Provide valves with the following:

   a. Seats: suitable for 40 degrees F for cold water service and 250 degrees F for hot water service. Seats shall cover inside surface of body and extend over body ends.

   b. Bodies: ductile iron or cast iron.

   c. Discs: Bronze or stainless steel.

   d. Stems or Shafts: Stainless steel. Install valves with stems horizontal.

   e. Control Handles: Suitable for locking in any position or with 10 degree or 15 degree notched throttling plates to hold valve in selected position. Provide extended necks to compensate for insulation thickness. Provide gear operator for valves 5 inches and larger.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

   a. 2 through 12 inches: Watts Regulator Co., model DBF-03.

F. Silent Check Valves (for use on pump discharge):

1. General: Provide spring loaded check valves at pump discharge of all pumps.

   a. 2 inches and smaller: Minimum 300 psi CWP, bronze body, Apollo 61LF, Milwaukee UP548-T, or equal.

   b. 2-1/2 inches and larger: Class 250, cast iron body, suitable for regrinding, Mueller 103MAP, or equal.

G. Calibrated Balancing Valves:

1. General: Calibrated orifice ball type rated for 400 psig maximum operating pressure and 250 degrees F. maximum operating temperature.

   a. Body: Brass.

   b. Ball: 304 Stainless Steel.

   c. Seat: Glass and Carbon filled TFE.

   d. End Connections: Threaded.

   e. Pressure Gage connections: Integral capped readout valves with internal check valves and drain port, for use with portable pressure differential meter.

   f. Handle Style: Dial, with memory stops to retain set position.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

   a. 3 Inch and Smaller: Bell & Gossett model CB, “LF” series.

2.7 VALVES AND FITTINGS FOR NON-POTABLE WATER, COMPRESSED AIR, AND GAS SYSTEMS

A. Gate Valves:

1. 2-1/2 inches and smaller: Class150, bronze body, union bonnet, rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Hammond IB641, IB648, Nibco T-134, S-134, Milwaukee 1151, 1169, or equal.

2. 3 inches and larger: Class 125, iron body, bronze mounted, bolted bonnet, non-rising stem, solid wedge, flanged ends, conforming to MSS SP-70. Hammond IR-1138, Nibco F619, Milwaukee F2882A, Stockham G-612, or equal.

3. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.

   a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.

   b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.

B. Ball Valves:

1. 2 inches and smaller: 600 psi CWP, 150 psi SWP, cast bronze body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T585-70, Milwaukee BA-400, Stockham T-285, or equal.

2. 2-1/2 inches and larger: Class 150, carbon steel body, full port, two piece, stainless steel vented ball, flanged ends, and reinforced PTFE seal, conforming to MSS SP-72. Nibco F-515-CS-F-66-FS, Milwaukee F20-CS-15-F-02-GO-VB, or equal.

3. Compressed Air Services: 600 psi CWP, 150 psi SWP, bronze body, full port, three piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco Model T-595-Y, Milwaukee BA-300, or equal.

C. Swing Check Valves: Class 125 or 150, bronze body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Stockham B-321, Milwaukee 509, Nibco T-433, or equal.

D. Butterfly Valves:

1. General: Tight closing, full lug type, with resilient seat suitable for minimum working pressure of 200 psig, conforming to MSS SP-67. Bi-direction dead end service with downstream flange removed.

2. Provide valves with the following:

   a. Seats: Suitable for 40 degrees F for cold water service and 250 degrees F for hot water service. Seats shall cover inside surface of body and extend over body ends.

   b. Bodies: Ductile iron or cast iron.

   c. Discs: Bronze or stainless steel.

   d. Stems or Shafts: Stainless steel.

   e. Control Handles: Suitable for locking in any position or with 10 degree or 15 degree notched throttling plates to hold valve in selected position. Provide extended necks to compensate for insulation thickness. Provide gear operator for valves 5 inches and larger.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. 2 through 12 inches: Milwaukee Valve, CL series, Nibco, Inc., Model LD2000-3, or equal.

E. Silent Check Valves (for use on pump discharge):

1. General: Provide spring loaded check valves at pump discharge of all pumps.

2. 2 inches and smaller: 250 psi CWP, bronze body, Nibco Model T-480, Milwaukee 548-T, or equal.

3. 2-1/2 inches and larger: Class 250, cast iron body, wafer style, suitable for regrinding. Nibco Model F960, Milwaukee 1400, Mueller 103MAP, or equal.

F. Calibrated Balance Valves (Symbol CBV): Provide globe style valves for precision regulation and control rated 175 psi for sizes 2-1/2 inches through 12 inches and rated 240 psi for bronze sizes 2 inches and below. Each valve shall have two metering/test ports with internal check valves and protective caps. All valves must be equipped with visual position readout and concealed memory stops for repeatable regulation and control.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. Bell & Gossett Circuit Setter Plus.

    b. Armstrong CBV.

    c. Flow Design Inc. Accusetter.

    d. Tour & Andersson.

    e. Circuit Sensor with butterfly valve above 3 inches.

    f. Illinois Series 5000 through 2 inches.

G. Flow Control Valves: Automatic pressure compensating flow control valves shall be Griswold, Flow Design, Inc., or equal.

H. Building Gas Shut-Off Valves:

1. 2 inches and smaller: Provide 175 psi SWP ball valve, CSA listed, full port, lockwing type, with AGA painted grey finish. Jomar 175-LWN, or equal.

2. Above 2 inches: Provide ReSun D-126, Key Port, or equal, lubricated plug cock, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.

3. Provide valves same size as upstream piping. Make any reduction in size of gas piping downstream of shutoff valves.

I. Gas Shut-off Valve Above Grade:

1. 2 inches and smaller: Provide Milwaukee BB2-100, Jomar T-100NE, or equal, ball valve, CSA listed, full port.

2. Above 2 inches: Provide ReSun D-126, Key Port, or equal, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.

3. Provide valves same size as upstream piping. Make any reduction in size of gas piping downstream of shutoff valves.

J. For Gas Service Below Grade:

1. Lubricated plug cocks: ReSun Model D-126, Key Port, or equal, lubricated plug cock, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide extended lubrication stem, arranged to allow for lubrication of the valve from grade. The extension must be constructed to allow for lubrication of the valve and for operation of the valve from grade. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.

   a. Provide flanged ends on valves installed below grade. Connect to polyethylene piping with flanges and stainless steel bolts.

   b. Anchor each valve flange to valve box with welded angle iron, or provide vertical stiff leg, minimum 18 inches into earth.

   c. Provide Central Double O Seal Transition Fittings, or equal, flanged style for connection between valve and piping system.

   d. Wrap valve, flanges and exposed pipe with PASCO Specialty & Mfg., Inc., or equal tape wrap, installed in accordance with requirements listed under “Pipe Protection”.

2. Molded polyethylene body ball valves: Nordstrom Valves - Polyvalve II for sizes 1-1/4 inches to 2 inches, and Polyvalve for sizes 2 inches and larger, or equal. Valves 1 inch and smaller shall be listed lubricated plug cocks, with transition fittings..

   a. Provide stub ends to match SDR of the piping, arranged for butt fusion welding. Provide valve body material to suit the adjacent piping system.

   b. Provide wrench to suit the valve operator.

K. Seismic Gas Shut-Off Valves: Certified by State of California and compliant with ASCE 25. Provide standard or high pressure model as required to match site gas pressure. Provide unit arrangement per Drawings schedule and details.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Little Firefighter Corporation, models NAGV, VAGV, and AGV.

   b. Seismic Safety Products, LLC, Northridge series.

2.8 DOMESTIC WATER PIPING SPECIALTIES

A. Hose Bibbs:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

    a. Acorn Engineering Co.

    b. Woodford Manufacturing Co.

2. Hose Station: Leonard THS-25-VB-CW, Symmons, or equal.

B. Wall Hydrants:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

    a. Acorn Engineering Co.

    b. Woodford Manufacturing Co.

    c. Mifab, Inc.

C. Water Hammer Arrestors:

1. Provide water hammer arrestors conforming to lead-free requirements of California Health and Safety Code Section 116875, with nesting type bellows contained within a casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system. Water hammer arrestors shall be sized for type and number of fixtures served. Provide all stainless steel shell construction with stainless steel bellows and threaded connection to water system.

2. Water hammer arrestors shall be certified under P.D.I. Standard WH201 and by ASSE Standard 1010.

3. Select units in accordance with the requirements of Plumbing and Drainage Institute Standard P.D.I. WH201. Install above ceilings or behind wall access door at each plumbing fixture, or where plumbing fixtures are installed in groups, at each group of fixtures.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. Josam Company, series 75000.

    b. Smith (Jay R.) Mfg. Co., Hydrotrol 5005-5050.

    c. Mifab, series WHB.

D. Water Filters:

1. Provide Cuno Incorporated, Aqua Pure model AP510, or equal, point of use water filters, conforming to lead-free requirements of California Health and Safety Code Section 116875, in locations indicated on Drawings.

    a. Provide model AP517 filter cartridge at each location, with 5 micron rating and 2,000 gallon rating, to remove sediment, rust, scale and chlorine taste and odor from incoming water. 2 gallon per minute capacity.

    b. Provide one spare cartridge for each unit provided.

E. Reduced Pressure Backflow Preventers for Potable Water Systems:

1. Provide reduced pressure principle backflow preventer conforming to lead free requirements of California Health and Safety Code Section 116875.

   a. Reduced-pressure principle backflow preventer assembly, consisting of shutoff valves on inlet and outlet, and strainer on inlet., Backflow preventer shall include test cocks, and pressure differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard 1013.

   b. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

      1) 2 inches and smaller: Wilkins 975XL2, Febco LF825YRP, Watts LF919.

      2) 2-1/2 thru 10 inches: Wilkins 475AXL, Febco LF860RP.

      3) 2-1/2 and 3 inches: Watts LF009.

2. Provide LeMeur, Hot-Box, WattsBox, or equal, two piece reinforced aluminum, fiberglass, welded angle with expanded metal, backflow preventer enclosure, sized to suit the size of backflow preventer. Install on concrete pad, in accordance with manufacturer's written installation instructions.

3. Provide substantial padlock and chain to lock valves in open position, and turn key over to Project Inspector.

   a. Padlocks shall be as specified under Section 08 70 00.

   b. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.

4. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.

5. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.

6. Provide two concrete filled, 6-inch diameter pipe bollards to protect all exposed piping from motor vehicle damage.

F. Reduced Pressure Backflow Preventers for Non-Potable Water Systems:

1. Refer to Section 211000 for backflow preventers for fire protection service.

2. Provide reduced-pressure principle backflow preventer consisting of assembly, including shutoff valves on inlet and outlet, and strainer on inlet, equal to Febco 825Y or 880, as required Wilkins, Aames, or equal. Backflow preventer shall include test cocks, and pressure differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard 1013.

3. Provide LeMeur, Hot-Box, or equal, two piece backflow preventer enclosure, sized to suit the size of backflow preventer. Install on concrete pad, in accordance with manufacturer's written installation instructions.

4. Provide substantial padlock and chain to lock valves in open position, and turn key over to Project Inspector.

a. Padlocks shall be as specified under Section 08 70 00.

b. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.

5. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.

6. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.

7. Provide two concrete filled, 6-inch diameter pipe bollards to protect all exposed piping from motor vehicle damage.

8. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. Ames.

b. Febco Sales, Inc.

c. Watts Regulator Company.

d. Clow.

G. Double Check Valve Backflow Preventers:

1. Refer to Section 211000 for backflow preventers for fire protection service.

2. Provide double detector check valve assembly consisting of two spring loaded brass check valves, two cast iron bronze fitted gate valves and four test cocks, equal to Febco Model 856 or 876 as required. Construct in accordance with ASSE Standard 1048.

3. Provide LeMeur, Hot-Box, or equal, two piece backflow preventer enclosure, sized to suit the size of backflow preventer. Install on concrete pad, in accordance with manufacturer's written installation instructions.

4. Provide substantial padlock and chain to lock valves in open position and turn key over to Project Inspector.

a. Padlocks shall be as specified under Section 08 70 00.

b. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.

5. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.

6. Provide two concrete filled, 6 inch diameter pipe bollards to protect all exposed piping from motor vehicle damage.

7. Provide Christy, or equal, utility box sized as required to suit backflow assembly, complete with two piece reinforced concrete lid, concrete extensions, insulation and other construction details shown on the drawings.

8. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. Ames.

    b. Febco Sales, Inc.

    c. Watts Regulator Company.

    d. Clow.

H. Potable Water Pressure-Regulating Valve:

1. Provide pressure-regulating valves, single-seated, direct-operated type, bronze body, integral strainer, complying with requirements of ASSE Standard 1003, and the lead-free requirements of California Health and Safety Code Section 116875. Size for maximum flow rate and inlet and outlet pressure indicated on Drawings.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. Cla-Val Company.

    b. Watts Regulator Company.

I. Thermostatic Water Temperature Control Valve:

1. Provide thermostatic water temperature control valve conforming to lead free requirements of California Health and Safety Code Section 116875, with size as noted on Drawings, complete with union angle strainer checkstops. Valves shall be thermostatic type, with a maximum temperature setting as follows:

2. Provide surface recessed semi-recessed mounted, white enameled or stainless steel cabinet with locking door for control valves. Including:

    a. Control valve cabinet and valve shall be provided as a package, and include thermostatic water mixing valve, thermometer, safety checkstops, volume control valve and internal piping.

3. Where indicated on drawings, provide a temperature alarm system, utilizing a micro-processor based controller and solid state temperature controller. Provide audible and visual indication of high and low temperature set points. Provide required hardware and wiring for a complete operating system.

    a. Provide isolation transformer for control of the alarm system.

    b. Provide solenoid valve and shock absorber, installed and wired to the alarm module.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. Leonard Valve Company.

    b. Lawler Manufacturing Co., Inc.

    c. Powers.

J. Relief Valves:

1. Provide relief valves as indicated, of size and capacity as selected by Contractor for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.

2. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI A21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 degrees F, and pressure relief at 150 psi.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. Watts Regulator Company.

b. Cash (A.W.) Valve Manufacturing Corporation.

c. Zurn Industries, Inc.; Wilkins-Regulator Division.

K. Trap Primers:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

a. MiFab, Inc.

b. Precision Plumbing Products.

c. Sioux Chief Manufacturing Company.

L. Water Meter:

1. Provide and install prefabricated water meter and bypass assembly, sized as indicated on the Drawings, complete with strainer, adapter, couplings, spool piece and test nipple. The meter shall be compound type, with two measuring chambers and a single billing register. Pipe materials used in construction of the assembly shall be ductile iron, and the meter shall be bronze with stainless steel trim.

2. Install the meter and accessories in a Christy, Brooks, or equal, series "R" pit Model R37, 4 feet by 7 feet by 3 feet deep; complete with 4 piece checker plate parkway lid (screw down type), and 8 inch round meter reading lid. Install meter in accordance with the requirements of the Authority Having Jurisdiction.

3. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. Badger Meter, Inc.

b. Sensus North America Water.

c. Neptune Technology Group.

d. Hershey Meters.

2.9 GAS PIPING SPECIALTIES

A. Gas Pressure Regulating Valves:

1. Provide single-stage, spring-loaded, corrosion-resistant gas pressure regulators, with die-cast aluminum or cast iron body, complying with ANSI Z21.80. Unit shall be with atmospheric vent, internal relief overpressure protection, threaded ends for 2 inches and smaller, flanged ends for 2-1/2 inches and larger. For inlet and outlet gas pressures, specific gravity, and volume flow refer to Drawings schedule.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

Size	Manufacturer/Model
1/2 inch	Elster (American, Singer) model 1213B Itron (Actaris, Slumberger, Sprague) model B42R.
3/4 thru 1-1/4inches	Elster (American, Singer) model 1813C Sensus (Ivensys, Equimeter, Rockwell) model 143-80-12 Itron (Actaris, Slumberger, Sprague) models B42R, B57R, B58R
1-1/2 thru 2 inches	Elster (American, Singer) models 1813, 1813B Sensus (Ivensys, Equimeter, Rockwell) model 243 Itron (Actaris, Slumberger, Sprague) models B43SR, B34R, B38R

B. Gas and Air Outlets:

1. Gas Outlets: Deck mounted Chicago 982-907BC duplex, T&S Brass, or equal; deck mounted Chicago 980-907BC single, or equal, deck-mounted Chicago 984-907BC, four outlets, or equal. Provide integral check valve, and single lever handle in compliance with ADA requirements.

2. Air Outlets: Panel mounted Chicago 986-937CH; deck-mounted Chicago 980-937CH, T&S Brass, or equal. Provide integral check valve, and single lever handle in compliance with ADA requirements.

3. Air Hose Valve: Lincoln 815 coupler and 11659 nipple, Grover, or equal, with ball valve on inlet. Refer to drawing details for additional requirements. Provide Wilkerson Model CB6-04-000 air pressure regulator, or equal.

4. Hose Reels: Lincoln Model 85062, Grover or equal. Provide heavy-duty type with delivery hose, universal swivel, ball stop, shut-off valve, control valve and filter as required. Connect services to reels with ball valve.

2.10 DRAIN AND WASTE PIPING SPECIALTIES

A. Cleanouts:

1. General: Install cleanouts of same diameter as pipe (4 inch maximum) in all horizontal soil and waste lines where indicated and at all points of change in direction. Cleanouts shall be located not less than 18 inches from building construction so as to provide sufficient space for rodding. No horizontal run over 50 feet inside buildings or 100 feet outside buildings shall be without cleanout, whether shown on Drawings or not. Provide two-way cleanouts where indicated on drawings, and where required for satisfactory use.

a. Provide cleanouts in waste drop from each sink and urinal.

b. Provide one wrench for each size and type of cleanout used. Turn over to Owner at completion of the project, and obtain receipt. Place receipt in Operation and Maintenance Manuals.

2. Cleanouts in floor and in concrete sidewalks: Ducco Cast Iron with nickel bronze top, clamping collar and ABS plastic plug: Zurn ZN-1400-KC, or equal, with square or round top to suit floor construction.

3. Cleanouts in composition floors: Zurn ZN-1400-X-DX, or equal (nickel bronze top).

4. Cleanouts in concealed, aboveground cast-iron soil or waste lines: Zurn Z-1440A, or equal, with ABS plastic plug.

5. Cleanouts in walls: Zurn Z-1441 or Z-1443, or equal, with stainless steel cover. Provide long sweep elbow or combination wye at connection to riser and install with surface of cleanout within ½ inch of front face of finished wall.

a. Where space does not permit the above installation, provide Zurn Z-1446, or equal, with stainless steel access cover, and vandal resistant screw.

b. Install face of cleanout plug within 1/2 inch of front face of finished wall.

6. Cleanouts exterior to building in landscaped areas: Zurn Z-1449-BP, or equal, cleanout ferrule with tapered bronze plug. Where located at grade, provide 18 by 18 by 6 inch concrete pad; Trowel concrete smooth and edge; set flush with finished grade.

7. Cleanouts in drive areas: Zurn -1400-HD-KC, or equal, with heavy-duty top and ABS plastic plug.

8. Cleanouts in acid waste systems: Zurn ZN-1404, or equal, cleanout access housing, with ductile cast iron body and nickel bronze top. Extend acid waste piping within the cleanout, and terminate with threaded cap. Secure acid waste pipe inside cleanout access housing with setscrews provided.

B. Floor Drains:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

a. J.R. Smith.

b. MIFAB.

c. Watts.

d. Zurn.

C. Floor Sinks:

1. Floor Sinks: Provide anchoring flange (seepage pan) at all floor sinks, and provide flashing clamp in locations where floor membrane is used. Provide cast iron "P" trap and trap primer connection at P-Trap.

2. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

a. J.R. Smith.

b. MIFAB.

c. Watts.

d. Zurn.

D. Hopper Drains:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

a. Zurn.

b. J.R. Smith.

E. Area Drain:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

a. Brooks.

b. J.R. Smith.

c. Old Castle Precast.

d. Watts.

e. Zurn.

F. Backwater Valves:

1. Provide Zurn Model Z-1090 J. R. Smith 7012, or equal flapper type backwater valve where indicated on drawings. Install in accordance with manufacturer's recommendations.

2. Provide Christy Model B16, Brooks, or equal utility box, 12 inches by 22 inches size, for installation of backwater valve.

3. Provide Zurn Model Z-1091, J.R. Smith 7070, or equal terminal type backwater valve, and install in catch basin piping at the outlet of the catch basin.

G. Roof Drains and Overflow Drains:

1. See Architectural Drawings for drain style to be used.

2. Provide offset downspout boots where required for connection of exposed sheet metal downspouts to underground cast iron or PVC piping.

3. Provide rainwater leader nozzles on overflow piping. Nozzle body shall be bronze with threaded inlet and bronze wall flange with mounting holes. Size nozzle to match connected rainwater leader.

4. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:

   a. J.R. Smith.

   b. Mifab.

   c. Zurn.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which plumbing piping systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

B. Make all arrangements for the utilities required. Pay all costs involved in obtaining the services including gas service and meter, water meter, pressure reducing valve, access boxes, street work. Connect to site utilities. Verify the location of all services. No extra cost will be allowed if services are not as shown.

C. Determine sanitary sewer and storm drain location and elevation at all points of connection before installing any piping. Notify Architect immediately if indicated grades cannot be maintained.

D. At time of final connection, and prior to opening valve to allow pressurization of water and gas piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on water piping is greater than 80 psi, or gas pressure is not as indicated on Contract Documents, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.

3.2 INSTALLATION OF WATER PIPING

A. Run all water piping generally level, free of traps or unnecessary bends, arranged to conform to the building requirements, and to suit clearance for other mechanical work such as ducts, flues, conduits, and other work. No piping shall be installed so as to cause unusual noise from the flow of water therein under normal conditions.

B. Provide manufactured water hammer arrestors, sized and installed in accordance with Plumbing and Drainage Institute Standard PDI WH201.

   1. Locate water hammer arrestors at every plumbing fixture, or, where fixtures are located in groups, at every group of fixtures, and as indicated on Drawings.

   2. Install water hammer arresters above accessible ceilings, or install access doors for service.

C. In freezing locations arrange water piping to drain as shown.

D. Install piping on room side of building insulation.

E. Check final location of rubber rings within couplings on PVC water piping with gauge or as recommended by manufacturer. Make connection to valves with cast iron adapters connected to water pipe with cast iron couplings. Furnish and install anchors or thrust blocks.

F. For all faucets, hose bibbs, or other water outlets delivering industrial hot and/or cold water, provide a sign, permanently mounted, indicating "CAUTION: NON-POTABLE WATER, DO NOT DRINK". Each sign shall be permanently engraved with black uppercase letters on a yellow background. Letters shall be minimum 1-1/4 inch high.

3.3 INSTALLATION OF SANITARY AND STORM DRAINAGE SYSTEMS

A. Make joints in PVC sewer pipe with PVC-type couplings and rubber rings.

B. Check final location of rubber rings within the couplings with gauge or as recommended by the manufacturer. Make joints between PVC pipe and cast iron pipe or fittings using cast iron adapter fittings, installed as recommended by the manufacturer.

1. Ring-Tite cast iron pipe fittings may be used in lieu of standard fittings. Make connection to valves with cast iron adapters connected to the pipe with PVC couplings.

C. Sewer Piping: Run all horizontal sanitary drain piping inside of building on a uniform grade of not less than 1/4 inch per foot unless otherwise noted or later approved. Unless otherwise noted on the plans, piping shall have invert elevations as shown and slope uniformly between given elevations.

D. Storm Drain Piping: Run all horizontal storm drain piping inside of building on a uniform grade of not less than 1/4 inch per foot. Unless otherwise noted on the plans, piping shall have invert elevations as shown and slope uniformly between given elevations.

E. Install rainwater leader nozzles at exposed bottom of leaders where they spill onto grade.

F. Run all drainage piping as straight as possible and provide easy bends with long turns; make all offsets at an angle of 45 degrees or less.

G. Grade all vent piping so as to free itself quickly of any water condensation.

H. Where possible, join groups of vent risers together with one enlarged outlet through roof. Maintain minimum of 10 foot horizontal or 3 foot vertical clearance from air intakes.

I. Install drip pan under storm drain piping, sanitary drain piping, and vent piping that must be run over kitchen areas.

J. Hubless Cast Iron Joints: Comply with coupling manufacturer's installation instructions.

3.4 INSTALLATION OF GREASE WASTE PIPING SYSTEMS

A. Install to comply with all manufacturers’ recommendations.

B. All buried pipe shall be bedded in and backfilled with 4 inches of sand, and installed as recommended by manufacturer.

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Maintain continuous pressure test on piping installed below grade, until all work has progressed to above grade.

D. Electrofusion joints: Make polypropylene drainage piping joints according to ASTM F 1290.

3.5 INSTALLATION OF ACID WASTE PIPING SYSTEMS

A. Install to comply with all manufacturers’ recommendations.

B. All buried pipe shall be bedded in and backfilled with 4 inches of sand, and installed as recommended by manufacturer.

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Maintain continuous pressure test on piping installed below grade, until all work has progressed to above grade.

D. Electrofusion joints: Make polypropylene drainage piping joints according to ASTM F 1290.

E. Connection to Building Sewer: At point of connection of acid waste piping to building sewer, provide fitting of same material as acid waste piping.

3.6 INSTALLATION OF NATURAL GAS PIPING

A. Install natural gas piping in accordance with Division 22 Basic Plumbing Materials and Methods sections.

B. Use sealants on metal gas piping threads that are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.

C. Remove cutting and threading burrs before assembling piping.

D. Do not install defective piping or fittings. Do not use pipe with threads that are chipped, stripped, or damaged.

E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.

F. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.

G. Install drip-legs in gas piping where indicated and where required by code or regulation.

1. Install "Tee" fitting with bottom outlet plugged or capped at bottom of pipe risers.

2. Where gas supply is connected to equipment with flexible connectors, install drip-leg in piping on downstream side of flexible connector, and install shut off valve on piping on upstream side of flexible connector.

H. Install piping with 1/64 inch per foot (1/8 percent) downward slope in direction of flow.

I. Install piping parallel to other piping.

J. Paint all gas piping installed in exposed exterior locations. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods, article, Painting.

K. Provide shutoff valve downstream of meter.

L. Provide exterior shutoff valve at each building. Provide sign affixed to wall at valve location reading: “Gas Shut-Off.” Size and location of the sign shall be as required by the Authority Having Jurisdiction. Where gas piping enters a building in more than one location, exterior shutoff valves shall have a permanently attached metal tag identifying the area served by that valve, in addition to sign on wall.

M. Provide watertight Schedule 40 PVC conduit to protect gas piping installed below covered walk, covered driveways, and where noted on Drawings. Extend sleeve at least 12 inches beyond any area where it is required to be installed, and terminate with valve box extended to grade, and marked “GAS”.

N. Maintain minimum of 12 inch clearance between gas piping and steam piping above 200 degrees F.

3.7 PIPE JOINTS AND CONNECTIONS

A. General:

1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.

3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.

B. Threaded Pipe: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply thread compound to external pipe threads: Rectorseal No. 5, Permatex No. 1, or equal.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

D. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3. PVC Piping: Join according to ASTM D 2855.

E. Copper Pipe and Tubing (Except pneumatic control piping): All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except domestic water piping 1-1/4 inches and smaller when not buried in the ground or concrete and type DWV plumbing piping may be soldered.

1. Soldered joints: Apply water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828.

F. Cast Iron Soil Pipe:

1. No-Hub fittings shall be made with a torque wrench.

2. Hub joints shall be with Ty-Seal couplings.

3. Wrought iron, steel, or copper pipe shall have a ring or part of a coupling screwed on to form a spigot end if caulked into a joint.

4. Connect cast iron sewer piping to outside service pipe with cast iron or vitrified LOP reducers or increasers as required. Caulking of smaller pipe into the larger without a reducer or increaser will not be permitted.

G. Welded Pipe:

1. Make up with oxyacetylene or electric arc process.

2. All line welds shall be of the single "V" butt type. Welds for flanges shall be of the fillet type.

3. Where the branch is two pipe sizes smaller than the main or smaller, Bonney Weldolets, Threadolets, Nibco, or equal, may be used in lieu of welding tees.

H. PVC Sewer and Drainage Pipe (outside building as allowed only): Four inches and larger shall be bell and spigot, assembled in accordance with manufacturer's recommendations. Joint shall be tested in accordance with ASTM D3212. Solvent weld joints below 4 inches in size, schedule 40 PVC with matching fittings, assembled per manufacturer’s instructions.

I. Polyethylene and Polypropylene Pipe: Assemble with fusion joints in strict accordance with manufacturer's instructions.

J. Make joints in PVC water pipe with PVC couplings and rubber rings, Manville Ring-Tite, PW Pipe, or equal. Check final location of rubber rings with the couplings with gauge or as recommended by the manufacturer. Make joints between PVC pipe and cast iron pipe or fittings using cast iron or PVC adapter fittings, installed as recommended by the manufacturer. Ring-Tite PVC or cast iron pipe fittings may be used in lieu of standard fittings. Make connection to valves with cast iron adapters connected to the water pipe with PVC couplings.

K. Flexible Connections:

1. Furnish and install Thermo Tech., Inc. F/J/R, Metraflex, or equal, flexible couplings with limiter bolts on piping connections to all equipment mounted on anti-vibration bases, on each connection to each base mounted pump and where shown. Couplings shall be suitable for pressure and type of service.

2. Anchor piping securely on the system side of each flexible connection.

3.8 INSTALLATION OF VALVES

A. Install valves as indicated on Drawings and in the following locations:

1. Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.

2. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere indicated or required to completely drain potable water system.

3. Provide gate or globe valves on inlet and outlet of each water heater or pump.

B. General:

1. Valves shall be full line size unless indicated otherwise on Drawings.

2. Install horizontal valves with valve stem above horizontal, except butterfly valves.

3. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

4. Locate valves for easy access and provide separate support where necessary.

5. Install valves in position to allow full stem movement.

6. Install exposed polished or enameled connections with special care showing no tool marks or exposed threads.

7. Butterfly valves conforming to the paragraph “Butterfly Valves” may be used in lieu of gate or globe valves for locations above grade.

8. Ball valves conforming to the paragraph “Ball Valves” may be used in lieu of gate valves for locations above grade for services 2-1/2 inches and smaller.

9. Valves 2-1/2 inches and smaller (except ball valves) in nonferrous water piping systems may be solder joint type with bronze body and trim.

10. Rigidly fasten hose bibbs, hydrants, fixture stops, compressed air outlets, and similar items to the building construction.

C. Gate Valves:

1. Furnish valves in copper lines with adapters to suit valve / line requirements.

2. Underground gate valves:

a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.

b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.

D. Swing Check Valves: Install in horizontal position with hinge pin level.

E. Butterfly Valves: Install with stems horizontal.

F. Silent Check Valves: Install in horizontal or vertical position between flanges.

G. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers' recommendations, including requirements for straight pipe lengths at valve inlet and outlet.

H. Gas Shut-Off Valves:

1. Provide line size ball valve in gas line to each appliance.

2. Provide line size ball valve in gas line, to be used as emergency shut-off for science classrooms. Install valve in locking box where indicated on the drawings.

3. Provide line size electric solenoid gas valve in gas line to kitchen equipment (if not supplied with appliance) under Type 1 hood. Interlock with hood fire alarm system.

I. Valve Adjustment: Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.9 INSTALLATION OF CLEANOUTS

A. Cleanouts: Install in piping as indicated, as required by California Plumbing Code, at each change in direction of piping greater than 45 degrees. Install at maximum intervals of 50 feet for piping 4 inches and smaller and 100 feet for larger piping inside buildings, and at base of each conductor.

B. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing through water resistant membrane.

3.10 INSTALLATION OF FLOOR DRAINS AND FLOOR SINKS

A. Install drains in accordance with manufacturer's written instructions and in locations indicated. Install floor drains with lip of drain slightly below finished floor to ensure drainage. Install floor sinks flush with finished floor. Coordinate with other trades to ensure that floor slopes to drain. Provide flashing flange and clamping device with each drain passing through water resistant membrane.

B. Install vented P-trap below each drain. Where trap primers are indicated, install trap primer connection in the P-trap.

3.11 INSTALLATION OF ROOF DRAINS AND OVERFLOW DRAINS

A. Install roof drains and overflow roof drains in accordance with manufacturer's written instructions and in locations indicated.

B. Coordinate with roofing as necessary to interface roof drains with roofing work.

3.12 INSTALLATION OF HOPPER DRAINS

A. Install hopper drain in wall, in sheet metal box, with access door.

1. Size access door and box to suit the size required for hopper drain and trap primer, and solder all seams of box. Seal all penetrations to box with non-hardening waterproof sealant. Provide locking door in occupied spaces.

B. Grind top and sides of funnel, if required, to suit wall thickness.

3.13 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers where indicated on Drawings. Provide drain connection available from the manufacturer at drain connection, pipe drain outlet to the nearest floor drain.

1. Where drain pans are shown on the Drawings, pipe drain pan outlet to nearest floor drain.

3.14 TRAP PRIMER INSTALLATION

A. Install as indicated in manufacturers printed literature, with 1/2 inch, Type L, hard copper piping to trap primer connection on floor drains and floor sinks where indicated on Drawings. At Contractor’s option, Type K annealed copper tubing without joints may be used be used below slab only. See Section 22 00 50 for pipe protection requirements for below slab copper piping/tubing.

B. Install trap primer piping with 1/4 inch per foot slope, to insure that the line will drain fully to the floor drain or floor sink.

1. Provide ball valve to the inlet at each trap primer location.

C. Install trap primer and distribution unit exactly as called for in manufacturers printed installation instructions. Connect to domestic water piping from the top of the water line, in order to prevent foreign material from entering directly into primer assembly.

D. Mount trap primer in wall, in sheet metal box, with Karp or equal access door. Size access door and box to suit valve operation, and solder all seams of box. Seal all penetrations to box with non-hardening waterproof sealant. Provide locking door where installed in occupied spaces.

E. Where one trap primer will be used for more than one trap, provide a distribution unit with feeder piping for a maximum of four traps sized for equal pressure drop to each trap.

3.15 INSTALLATION OF GAS PRESSURE REGULATING VALVES

A. Install as indicated; comply with utility requirements. In locations where regulators are installed in confined spaces, pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream and downstream of each pressure-regulating valve.

3.16 GAS PIPING EQUIPMENT CONNECTIONS

A. Connect gas piping to each gas-fired equipment item, with union, drip leg and shutoff gas cock full size of supply line shown. Reduce only at connection to equipment. Comply with equipment manufacturer's instructions.

1. Route gas vent and gas relief to outside.

2. Gas shutoff valve shall be placed as close as possible to equipment in a location where it can be serviced. Distance from equipment to valve shall not exceed 6 feet.

3.17 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated.

B. Mechanical Equipment Connections: Connect hot and cold water piping system and gas piping system to mechanical equipment as indicated, and provide with shutoff valve and union for each connection.

3.18 KITCHEN EQUIPMENT INSTALLATION

A. Coordinate all work with Specification Section for kitchen equipment.

B. All equipment shall be fully connected.

C. Furnish and install all required "P" traps.

D. Provide stops on all hot and cold water lines at equipment, in an accessible position. Include lines to kettle and range swing faucets.

E. Water pressure for dishwasher and glass-washer to be 25 pound maximum. Provide pressure reducing valves on water line to washers.

F. All floor openings are to be sealed watertight.

G. Indirect waste lines required for standard or fabricated items of kitchen equipment, except sinks, shall be furnished and installed by the kitchen equipment contractor.

H. Provide all sink drains. All indirect drains shall terminate above floor sinks at least 1-1/2 times ID of drain line and shall be so set that flare will not spill on floor area.

I. Provide approved vacuum breaker or anti siphon device on water lines to equipment wherever required.

J. Provide gas pressure regulators for modular front manifold cooking equipment assemblies. Pressure regulators shall be adjustable from 2 inch to 7 inch water column and shall be set for approximately 6 inches W.C. at manifold connection.

K. All gas pressure regulators shipped loose with gas fired equipment shall be installed by plumbing contractor.

L. The kitchen equipment contractor will provide all equipment trim including faucets and sink wastes and swing faucets at kettles all to be installed by Plumbing contractor.

M. All horizontal piping lines connected to equipment shall be run at the highest possible elevation not less than 6 inches above floor. Piping rough-in shall be stubbed in walls wherever possible.

N. Vent piping for waste lines shall be concealed wherever possible and vertical vents for island or free-standing equipment shall be avoided. Any required exposed vents shall be submitted to the Architect for approval.

O. Kitchen equipment contractor to furnish coffee maker. Plumbing contractor shall provide a cold water connection terminating in a 3′-0″ length of 1/4 inch OD soft copper tubing with a 1/4 inch female flare fitting on the end.

P. Fire protection systems for ventilators and cooking equipment are furnished and installed by kitchen equipment contractor unless shown otherwise on the drawings. Gas valves which are a part of the fire protection systems are furnished only. Plumbing Contractor shall install gas valves.

Q. Connect movable gas-fired cooking equipment utilizing flexible gas connection system.

3.19 LABORATORY EQUIPMENT AND CASEWORK INSTALLATION

A. Coordinate all work with Specification Section for Laboratory Equipment and Casework.

B. Furnish and install all required P-traps. Traps shall be Enfield, Fuseal, or equal.

C. Provide stops on all hot and cold water lines at equipment in an accessible position.

D. Seal floor openings watertight.

E. Provide approved vacuum breaker or anti-siphon device on water lines to equipment wherever required.

F. All horizontal piping lines connected to equipment shall be run at the highest possible elevation not less than 6 inches above floor. Piping rough-in shall be stubbed in walls wherever possible.

G. Vent piping for waste lines shall be concealed and vents for island or freestanding equipment shall be looped.

3.20 DOMESTIC WATER SYSTEM STERILIZATION

A. Clean and disinfect new or altered hot and cold water piping connected to domestic water systems using methods prescribed by the Health Authority. If the Health Authority does not prescribe methods, clean and disinfect new or altered hot and cold water piping using methods given in the California Plumbing Code.

1. A water treatment company that has a current state EPA license to apply disinfectant chlorine in potable water shall perform the procedure.

3.21 CARE AND CLEANING

A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures, and trim that are installed as part of this work. Remove labels from stainless steel sinks, except 316 stainless steel sink labels should be retained to confirm that the correct material has been provided. Leave systems and equipment in satisfactory operating condition.

3.22 OPERATIONAL TESTS

A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.23 TESTING AND BALANCING

A. See Section 23 05 93 of Specifications for testing and balancing requirements.

3.24 CLEANING UP

A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

[END OF SECTION 22 10 00]

SECTION 23 80 00

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof mounted air conditioning units.
2. Roof mounted heat pump units.
3. Heating and ventilating units.
4. Split system heat pump units.
5. Split system air conditioning units.
6. Variable Refrigerant Flow - Split system heat pump units.
7. High efficiency furnace units.
8. Air cooled condensing units.
9. Cooling coils.
10. Refrigerant piping and fittings.
11. Electric radiant ceiling panels.
12. Fans.
13. Kitchen exhaust hood – type 1.
14. Kitchen exhaust hood – type 2.
15. Kiln exhaust hood system.
16. Welding exhaust system.
17. Relief and intake vents.
18. Louvers.
19. Air inlets and outlets.
20. Terminal Units.
21. Filters.
22. Dampers.
23. Ductwork.
24. Hydronic Piping.
25. Hydronic pumps.

26. Hydronic Piping Specialties.

27. Expansion loops.

28. Valves.

29. Valve boxes.

30. Insulation.

31. Thermal hanger shield inserts.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 23 00 50, Basic HVAC Materials and Methods.

C. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

D. Section 23 09 23, Direct Digital Control (DDC) System for HVAC.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings:

1. Variable Refrigerant Flow System Conference: Installing contractor’s foreman shall attend conference at Project site with design Engineer and equipment manufacturer’s representative, to comply with requirements of this Section and manufacturer’s installation requirements including but not limited to, the following:

a. Proposed deviations from system as shown and described in Contract Documents, including location of system components and impacts to refrigerant pipe sizing.

1) Provide Coordinated Layouts as required by this Section for use in discussion.

b. Refrigerant piping assembly practices.

c. General discussion, question and answer period.

d. Walk site with equipment manufacturer’s representative to identify conditions affecting installation of system as designed.

1.4 ACTION SUBMITTALS

A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.

B. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, weight, corner or mounting point weights, furnished specialties and accessories; and installation and start-up instructions. Product data shall include applicable product listings and standards. Refer to Section 23 00 50, Basic HVAC Material and Methods for additional requirements.

1. Upon approval of submittal, provide manufacturer’s installation and operating instructions to the Project inspector for the following:

a. Fire dampers, smoke dampers, and combination smoke-fire dampers.

b. Type 1 kitchen exhaust field applied grease duct enclosures.

C. VRF Systems: Submit system documentation for a fully engineered system, including shop drawings, and wiring and control diagrams, showing location of required manufactured system components, component model numbers and capacities, and size and location of all field-installed components, including piping, required seismic and thermal expansion loops, and wiring. Identify proposed deviations from system as shown in Contract Documents.

D. Engineering Data: Submit fan curves and sound power level data for each fan unit. Data shall be at the scheduled capacity. Data shall include the name of the rating agency or independent laboratory.

1.5 INFORMATIONAL SUBMITTALS

A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.

B. Roof Curb Data: For roof mounted equipment where combined weight of equipment unit and roof curb or rail exceeds 400 pounds, submit calculations from manufacturer for roof curbs proving compliance with the seismic requirements of the California Building Code, and ASCE 7-10. Manufacturer shall certify that roof curbs are suitable for use indicated on Drawings and in Specifications for the seismic design category indicated in structural Contract Documents. Calculations shall be stamped and signed by a State of California registered structural engineer.

C. Economizer Fault Detection and Diagnostics (FDD) System Data: For all air-cooled unitary direct-expansion units equipped with an economizer, provide data for third-party supplied California Energy Commission certified FDD controller, documenting compliance with the requirements of California Building Energy Efficiency Standards. Provide evidence of certification.

D. Record of pre-installation meeting.

E. Training Certificates of Completion: Submit certificate from equipment manufacturer, indicating attendance and successful completion of manufacturer’s training program for variable refrigerant flow systems installation and service. Training shall include manufacturer’s preferred methods for assembling and insulating refrigerant piping and accessories.

F. Coordinated Layouts: Submit coordinated layouts. For requirements refer to article, Coordinated Layouts, in this Section.

1.6 CLOSEOUT SUBMITTALS

A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.

B. Maintenance Data: Submit maintenance data and parts list for each piece of equipment, control, and accessory; including "trouble-shooting guide," in Operation and Maintenance Manual.

C. Record Drawings: Submit Record Drawings of installed ductwork, duct accessories, and outlets and inlets in accordance with requirements of Division 01.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

2. Provide one complete set(s) of MERV-13 filters for each 4” filter bank.

1.8 COORDINATED LAYOUT

A. Coordinated layouts are required to amplify, expand and coordinate the information contained in the Contract Documents.

B. Provide minimum 1/4 inch equals one foot scaled coordinated layout drawings showing plan and pertinent section or elevation views of piping, ductwork, equipment, accessories, and electrical systems. Drawings shall be reproducible and work of each trade represented shall be fully coordinated with structure, other disciplines, and finished surfaces. Drawings shall be presented on a single size sheet. Coordinated layout drawings shall have title block, key plan, north arrow and sufficient grid lines to provide cross-reference to design Drawings.

1. Provide a stamp or title block on each drawing with locations for signatures from all contractors involved, including but not limited to the General, HVAC, Plumbing, Fire Protection, and Electrical contractors. Include statement for signature that the contractor has reviewed the coordinated layout drawings in detail and has coordinated the work of his trade.

2. Show on drawings the intended elevation of all ductwork in accordance with the following example:

   B.O.D. = 9'-0"
   OFFSET UP 6"
   B.O.D. = 9'-6"

3. Highlight, encircle or otherwise indicate deviations from the Contract Documents on the coordinated layouts. Architect will not be responsible for identifying deviations from the original Contract Documents.

C. Since scale of contract drawings is small and all offsets and fittings are not shown, Contractor shall make allowances in bid for additional coordination time, detailing, fittings, offsets, hangers and the like to achieve a fully coordinated installation. If changes in duct size are required, equivalent area shall be maintained and the aspect ratio shall not be in excess of 2 to 1 unless approved by the engineer. Drawings shall be submitted for review prior to fabrication and installation. Drawings may be submitted in packages representing at least one quarter of the building ductwork.

D. Check routing on all ductwork before fabricating. Report any discrepancies to Architect. No extra cost will be allowed for failure to conform to above.

1.9 QUALITY ASSURANCE

A. Design Criteria:

1. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture. All gas-fired equipment shall be UL, ETL or CSA listed.

2. Supply all equipment and accessories in accordance with requirements of applicable national, state and local codes.

3. All items of a given type shall be products of the same manufacturer.

4. Scheduled equipment performance is minimum capacity required.

5. Scheduled electrical capacity shall be considered as maximum available.

6. Scheduled gas BTU input shall be considered as maximum available.

B. Pump types and sizes regulated by the US Department of Energy's "Energy Conservation Standards for Pumps" 10 CRF Parts 429 and 431 shall be marked with a compliant PEI_{CL} or PEI_{VL} (Pump Energy Index, constant or variable load) value, basic model number, and RPM on the nameplate. Regulated pumps shall be listed in the Hydraulic Institute (HI) Energy Rating database (er.pumps.org) and be assigned an Energy Rating as defined in the HI 40.5 program guide.

C. Variable Refrigerant Flow Split-System Heat Pump Installer Training: Installing contractor shall have completed training in installation and service of VRF system, by equipment manufacturer.

1. Installing contractor shall obtain, at his own cost, equipment manufacturer's VRF system service tool, unless service tool is normally resident on controller specified for this Project.

1.10 FIELD CONDITIONS

A. Interruption of Existing Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of services.

2. Do not interrupt services without Architect's written permission.

1.11 WARRANTY

A. Air Conditioning Unit, Roof-Mounted:

1. Compressor shall have a five-year warranty.

2. Standard heat exchanger shall have a ten-year warranty.

B. Heat Pump Unit, Roof-Mounted: Compressor shall have a five-year warranty.

C. Heating and Ventilating Unit: Heat exchanger shall have minimum 10-year warranty.

D. High Efficiency Furnace Unit:

1. Heat exchangers shall have a 20-year warranty.

2. Entire unit shall have a 5-year warranty.

E. Air Cooled Condensing Unit: Unit shall have 5-year limited compressor warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.2 GAS FIRED EQUIPMENT

A. All gas-fired equipment shall be listed for use as a gas appliance.

B. All units shall comply with the emissions requirements of the Air Quality Management District (AQMD) in which they are to be installed.

2.3 AIR CONDITIONING UNIT, ROOF-MOUNTED

A. Provide factory assembled single packaged outdoor rooftop mounted, electrically controlled gas heating and electric cooling unit, rated in accordance with ARI Standards 210/240 or 340/360, and ETL or UL listed and labeled, classified in accordance with UL 1995. Provide refrigerant charge R-410A, all internal wiring, piping, controls, and special features required prior to field startup. Design unit to conform to the following:

1. California NOx emission requirements.

2. ASHRAE 15.

3. ASHRAE 90.1.

4. Insulation, adhesive, and all materials exposed to air stream shall meet NFPA 90A requirements for flame spread and smoke generation.

5. Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).

B. Unit shall be rated in accordance with ARI sound standards 270 or 370.

C. Unit shall be ETL or UL tested and certified in accordance with ANSI Z21.47 Standards as a total package.

D. Roof curb shall be designed to conform to NRCA Standards.

E. Unit shall be designed and manufactured in accordance with ISO 9001.

F. For unit sizes applicable to Energy Star program, units shall be Energy Star qualified.

G. Cabinet:

1. Provide galvanized steel unit cabinet, bonderized and coated with a baked enamel finish.

2. All airstream interior surfaces shall be insulated with a minimum 1/2 inch thick, 1.5 lb density cleanable insulation. Insulation shall be encapsulated with panel design or have sealed edges.

3. Cabinet panels shall be hinged with integrated non-corrosive hinges. Provide hinged access panels for the filter, compressors, evaporator fan, and control box/ heat section areas. Each panel shall have multiple latches and handles. Each external hinged access panel shall be permanently attached to the rooftop unit.

4. Return air filters shall be accessible through a dedicated hinged access panel.

5. Fork lift slots and rigging holes shall be provided in unit base rails. Base rails shall be minimum 16 gauge.

6. Unit shall have an integral sloped condensate drain pan, providing minimum 3/4 in.-14 NPT connections for horizontal drain configuration. Provide unit with alternate vertical thru-the-bottom drain connection when furnished as standard for units sizes scheduled on Drawings. See Drawings for drain configuration. Pan shall be removable for cleaning and maintenance. All drain pans shall conform to ASHRAE 62.1 self-draining provisions.

7. Unit shall have standard side and alternate field or factory installed thru-the-bottom power and control wiring connection capability. Thru-the-bottom electrical connections shall use manufacturer’s approved water-tight connection method.

8. Unit shall be field convertible to, or factory furnished with, horizontal air discharge, as applicable for unit sizes as scheduled on Drawings.

H. Fans:

1. Centrifugal supply air blower (evaporator fan) shall have sealed, permanently lubricated ball bearings, or rigid pillow block bearings, as supplied as standard equipment for unit sizes scheduled on Drawings. Units supplied with pillow block bearings shall be furnished with accessible lubricant fittings. Provide belt-driven double inlet fan wheel, centrifugal type with forward curved blades and adjustable sheaves. Multiple speed direct drive motors may be utilized when supplied as standard equipment for efficiency and electrical requirements as scheduled on the Drawings. Fan wheel shall be steel, with corrosion resistant finish, dynamically balanced.

2. Condenser fans shall be of the direct-driven propeller type, with corrosion-resistant aluminum blades. Fans shall be dynamically balanced and discharge air upwards. Induced-draft blower shall be of the direct-driven, single inlet, forward-curved, centrifugal type, made from aluminized steel with a corrosion-resistant finish and shall be dynamically balanced.

3. Induced draft fan shall be of the direct driven, single inlet, forward-curved centrifugal type. Fan wheel shall be steel, with corrosion resistant finish, dynamically balanced.

I. Motors:

1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have line break thermal and current overload protection.

2. Evaporator fan motor shall have permanently lubricated, sealed bearings and inherent automatic-reset thermal overload protection or manual reset calibrated circuit breakers.

3. Totally enclosed condenser-fan motor shall have permanently lubricated, sealed bearings, and inherent automatic-reset thermal overload protection.

4. Induced-draft motor shall have permanently lubricated sealed bearings and inherent automatic-reset thermal overload protection.

5. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

J. Compressor:

1. Fully hermetic, scroll type with internal high-pressure and temperature protection.

2. Factory installed rubber shock mounted and internally spring mounted for vibration isolation.

3. Compressor Anti-Recycle Timer: Compressor shall be prevented from restarting for a minimum of five minutes after shutdown, with manufacturers installed compressor cycle delay.

K. Coils:

1. Standard evaporator and condenser coils shall have aluminum plate fins mechanically bonded to seamless internally finned copper tubes with all joints brazed.

2. Units shall have face-split type evaporator coils.

3. For units with single compressor, condenser coils shall be single slab, single pass design. For dual compressor units, condenser coils shall be single slab, 2 pass design.

4. Evaporator coils shall be leak tested at minimum 150 psig, and pressure tested at minimum 450 psig.

5. Condenser coils shall be leak tested at minimum 150 psig, and pressure tested at minimum 650 psig.

L. Heating Section:

1. Induced-draft combustion type with direct-spark ignition system and redundant main gas valve with 2-stage capability on all 3-phase units.

2. Heat Exchanger:

a. The standard aluminized heat exchanger shall be of the tubular-section type constructed of minimum 20-gage aluminized steel.

3. Burners shall be of the in-shot type constructed of aluminum-coated steel.

4. All gas piping shall enter the unit at a single location. Gas entry shall be through side or bottom of unit. See Drawings for gas entry location. When bottom gas entry is utilized, unit shall be furnished with field installed conversion kit, arranged so that gas shut-off valve is accessible from the roof.

5. All factory-installed orifices are for operation up to 2,000 feet of altitude. For altitudes between 2,000 feet and 7,000 feet, a factory certified kit shall be furnished for field installation.

6. Units shall be suitable for use with natural gas or propane. Provide field-installed propane conversion kit as required, see schedule on Drawings.

7. The integrated gas controller board shall include gas heat operation fault notification using an LED (light-emitting diode).

8. Unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch or 4 continuous short cycles on the high-temperature limit switch. Fault indication shall be made using an LED.

9. The integrated gas controller board shall contain algorithms that modify evaporator-fan operation to prevent future cycling on high-temperature limit switch.

10. The LED shall be visible without removal of control box access panel.

11. Gas burner tray shall be removable for maintenance.

12. Heating section shall be insulated with foil-faced fiberglass insulation.

M. Refrigerant Components:

1. Each refrigerant circuit shall include:

a. Balanced port thermostatic expansion valve (TXV) with removable power element.

b. Solid core refrigerant filter driers with pressure ports.

c. Refrigerant pressure gage ports and connections on suction, discharge, and liquid lines.

N. Filter Section:

1. Standard filter section shall accommodate 4 inch deep filters. Filters shall conform to the “Air Filters” Article in this Specification Section.

2. Filter section shall use standard size filters.

O. Controls:

1. Unit shall be complete with self-contained low voltage fuse protected control circuit. Refer to Section 25 50 00, if included, and equipment schedule, sequence of operation and control diagram on Drawings for additional requirements.

2. When third party direct digital controls with an Energy Management System will be utilized, provide electro-mechanical controls with 24V thermostat interface.

3. When stand-alone thermostat operation is utilized, provide electro-mechanical controls with 24V thermostat interface or provide microprocessor controls.

4. When stand-alone thermostat operation is utilized for single-zone VAV units, provide microprocessor controls. Units shall have factory mounted supply fan variable frequency drives.

5. When third party direct digital controls with an Energy Management System will be utilized for single zone VAV units, provide microprocessor controls with BACnet or LON interface. Units shall have factory mounted supply fan variable frequency drives.

6. Electro-mechanical controls shall include the following, as a minimum:

    a. Service run test capability.

    b. Provide compressor minimum run time (3 minutes) and minimum off time (5 minutes).

    c. Economizer control.

    d. Unit shall have 35° F low ambient cooling operation.

    e. Time delay relay.

7. Microprocessor controls shall include the following, as a minimum:

    a. User diagnostic interface.

    b. Unit control with standard suction pressure transducers and condensing temperature thermistors.

    c. Shall provide a 5° F temperature difference between cooling and heating set points to meet ASHRAE 90.1 energy standard.

    d. Service run test capability.

    e. Shall accept input from a CO2 sensor (indoor).

    f. Configurable alarm light shall be provided which activates when certain types of alarms occur.

    g. Provide compressor minimum run time (3 minutes) and minimum off time (5 minutes).

    h. Service diagnostic mode.

    i. Economizer control.

    j. Unit shall have 0° F low ambient cooling operation.

    k. Time delay relay.

P. Safeties:

1. Unit shall incorporate a solid-state compressor lockout that provides optional reset capability at the space thermostat, should any of the following safety devices trip and shut off compressor:

    a. Compressor lockout protection provided for either internal or external overload.

    b. Low-pressure protection.

    c. Freeze protection (evaporator coil).

    d. High-pressure protection (high pressure switch or internal).

    e. Compressor reverse rotation protection.

    f. Loss of charge protection.

g. Start assist on singe-phase units.

2. Supply-air sensor shall be located in the unit and detect both heating and cooling operation.

3. Induced draft heating section shall be provided with the following minimum protections:

a. High-temperature limit switch.

b. Induced-draft motor speed sensor.

c. Flame rollout switch.

d. Flame proving controls.

e. Redundant gas valve.

4. Phase Protection: Provide unit-mounted “SymCom,” or equal, Motor Saver three phase voltage monitor, model 201A or equal, adjustable voltage range for each unit, install per manufacturer's recommendations, mount in NEMA 3R enclosure if exposed to the weather.

a. Units shall provide the following features:

1) Low voltage fault trip and reset.

2) Voltage unbalance/phasing fault trip and reset.

3) High voltage fault trip and reset.

4) Transient Protection (Internal).

5) Automatic restart.

b. Provide each unit with 600V socket, “SymCom” model OT08, or equal.

Q. Operating Characteristics:

1. Unit shall be capable of starting and running at 125° F ambient outdoor temperature per maximum load criteria of ARI Standards 210 or 360.

2. Unit will operate in cooling down to an outdoor ambient temperature of 35° F.

3. Unit shall be provided with fan time delay to prevent cold air delivery in heating mode.

R. Electrical Requirements:

1. All unit power wiring shall enter unit cabinet at a single location. Both unit side and bottom power entry provisions shall be provided. Refer to Drawings schedule for thru-the-bottom power wiring requirement.

S. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Carrier Corporation.

2. York, Johnson Controls, Inc.

3. Daikin

T. Provide the following additional features and equipment:

1. Roof Curb: Formed galvanized steel with wood nailer strip capable of supporting entire unit weight. Provide 3 inch wide bottom flange.

2. Provide heavy-duty 18 gauge expanded metal coil guard grille to protect all surfaces of the condensing coil. Coil guard by Micrometl, Canfab, or equal.

3. Modulating Power Exhaust Economizer: Micrometl, Canfab, or equal. Integrated type capable of simultaneous economizer and compressor operation.

    a. Provide self-contained outdoor rooftop system, mounted directly to the return air compartment of the HVAC packaged equipment. Provide differential dry bulb economizer control system and a factory programmed, fully programmable variable frequency drive package controlled by a differential pressure transmitter, mounted directly to the return air compartment of the HVAC packaged equipment. Design the system to continuously maintain space pressure, and provide capability of introducing up to 100 percent outdoor air.

        1) Economizer control system shall be certified as meeting the requirements for Fault Detection and Diagnostics (FDD) in the California Building Energy and Efficiency Standards.

    b. Provide outside differential pressure tubing termination with hex style pneumatic filter-muffler, minimum filtration 40 microns, 53 SCFM maximum at 100 psi, as manufactured by McMaster-Carr, or equal.

    c. Provide hinged cabinet access doors and include latches to provide a tool-less entry for servicing.

    d. Provide door lock on the power exhaust cabinet to meet ETL safety requirements.

    e. Outdoor air intake dampers shall be low leak not to exceed 3 percent at 1 inch wg pressure differential and include stainless steel side seal and neoprene edge seal. Arrange dampers to close upon loss of power.

    f. Provide belt driven exhaust blowers, double inlet, forward-curved centrifugal type. Provide gravity backdraft damper at fan outlet.

    g. Provide fully programmable factory programmed variable frequency drive (VFD) package for each fan, driven by 4 to 20 mA signal from a differential pressure transmitter. Pressure transmitters shall measure 0 - 0.1 in wg. Install room sensor tubing with sensor tube termination installed within the room.

        1) Where direct digital controls are utilized, provide Belimo, or equal, damper actuator, complete with spring return and all controls required to make the system fully operational.

        2) Where stand-alone controls are utilized, provide Belimo, or equal, damper actuator, complete with spring return and all controls, including logic module, required to make the system fully operational.

4. Gas Flue Extensions:

    a. Provide at all locations where gas flue outlet will be within 10 feet of an adjacent building forced air inlet, or mechanical unit air intake, and where indicated on Drawings.

5. Other features, accessories, and equipment scheduled on Drawings.

U. Replenish for a period of one year without cost to the Owner all refrigerant and oil required to maintain the proper levels.

V. Owner Training: Manufacturer shall provide two initial on-site 4-hour training sessions for Owners' maintenance personnel. Manufacturer shall provide one 4-hour follow-up training session to be scheduled by Owner within one year of the date of the final initial training session. Training session agenda shall be as follows:

1. First session: Equipment.

2. Second session: Controls.

3. Follow-up session: Agenda by Owner.

2.4 HEAT PUMP UNIT, ROOF-MOUNTED

A. Provide factory assembled single packaged outdoor rooftop mounted, electrically controlled electric cooling and heating unit, rated in accordance with ARI Standards 210/240 or 340/360, and ETL or UL listed and labeled, classified in accordance with UL 1995. Provide refrigerant charge R-410A, all internal wiring, piping, controls, and special features required prior to field startup. Design unit to conform to the following:

1. ASHRAE 15.

2. ASHRAE 90.1.

3. Insulation, adhesive, and all materials exposed to air stream shall meet NFPA 90A requirements for flame spread and smoke generation.

4. Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).

B. Unit shall be rated in accordance with ARI sound standards 270.

C. Unit shall be ETL or UL tested and certified in accordance with ANSI Z21.47 Standards as a total package.

D. Roof curb shall be designed to conform to NRCA Standards.

E. Unit shall be manufactured in a facility registered to ISO 9001:2000.

F. Unit shall be Energy Star qualified.

G. Cabinet:

1. Provide galvanized steel unit cabinet, bonderized and coated with a baked enamel finish.

2. All airstream interior surfaces shall be insulated with a minimum 1/2 inch thick, 1 lb density cleanable insulation. Heat compartment for optional electric heater shall be insulated with minimum 1/2 inch thick, 1 lb. density foil-faced insulation.

3. Cabinet panels shall be removable. Provide access panels for the filter, compressors, evaporator fan, and control box. Each external hinged access panel shall be insulated, with insulation encapsulated with panel or with sealed edges.

4. Return air filters shall be accessible through a dedicated tool-less removable access panel.

5. Fork lift slots shall be provided in unit base rail. Base rail shall be minimum 16 gauge.

6. Unit shall have a factory-installed internally sloped condensate drain pan, providing minimum 3/4 inch-14 NPT connections for both horizontal and alternate vertical drain configuration. See Drawings for drain configuration. Pan shall be removable for cleaning and maintenance. All drain pans shall conform to ASHRAE 62.1 self-draining provisions.

7. Unit shall have standard side and alternate field or factory installed thru-the-bottom power and control wiring connection capability.

8. Unit shall be field or factory convertible to horizontal air discharge.

H. Fans:

1. Centrifugal supply air blower (evaporator fan) shall have permanently lubricated bearings. Provide belt-driven double inlet fan wheel, centrifugal type with forward curved blades and adjustable sheaves. Fan wheel shall be steel, with corrosion resistant finish, dynamically balanced.

2. Evaporator-fan motors shall be continuous operation, open drip-proof, and thermally protected. Bearings shall be sealed, permanently lubricated ball-bearing type.

3. Condenser fans shall be of the direct-driven propeller type, with corrosion-resistant aluminum blades. Fans shall be dynamically balanced and discharge air upwards. Condenser-fan motors shall be totally enclosed and thermally protected.

I. Compressor:

1. Fully hermetic, scroll type with internal high-pressure and temperature protection. Furnish with crankcase heater when normally supplied as standard equipment for model size scheduled on Drawings.

2. Factory installed rubber shock mounted and internally spring mounted for vibration isolation.

3. Compressor Anti-Recycle Timer: Compressor shall be prevented from restarting for a minimum of five minutes after shutdown, with manufacturers installed compressor cycle delay.

J. Coils:

1. Standard evaporator and condenser coils shall have aluminum plate fins mechanically bonded to seamless internally finned copper tubes with all joints brazed.

2. Condenser coils shall be single slab, single pass design. Single slab, 2 pass design may be utilized when supplied as standard equipment for unit size as scheduled on the Drawings.

3. Coils shall be leak tested at minimum 150 psig and pressure tested at minimum 450 psig.

K. Refrigerant Components:

1. Each refrigerant circuit shall include:

a. Fixed orifice metering device.

b. Solid core refrigerant filter driers with pressure ports.

c. Refrigerant pressure gage ports and connections on suction, and discharge lines.

d. Suction line accumulator.

e. Reversing valve.

L. Filter Section:

1. Standard filter section shall accommodate 4 inch deep filters. Filters shall conform to the “Air Filters” Article in this Specification Section.

2. Filter section shall use standard size filters.

M. Controls:

1. Unit shall be complete with self-contained low voltage fuse protected control circuit. Refer to Section 25 50 00, if included, and equipment schedule, sequence of operation and control diagram on Drawings for additional requirements.

2. When third party direct digital controls with an Energy Management System will be utilized, provide electro-mechanical controls with 24V thermostat interface.

3. When stand-alone thermostat operation is utilized, provide electro-mechanical controls with 24V thermostat interface or provide microprocessor controls.

4. When stand-alone thermostat operation is utilized for single-zone VAV units, provide microprocessor controls. Units shall have factory mounted supply fan variable frequency drives.

5. When third party direct digital controls with an Energy Management System will be utilized for single zone VAV units, provide microprocessor controls with BACnet or LON interface. Units shall have factory mounted supply fan variable frequency drives.

6. Electro-mechanical controls shall include the following, as a minimum:

    a. Provide compressor minimum off time (5 minutes).

    b. Economizer control.

    c. Time delay relay.

    d. Integrated adjustable defrost cycle.

7. Microprocessor controls shall be ASHRAE 62.1 compliant and include the following, as a minimum:

    a. User diagnostic interface.

    b. Unit control with standard suction pressure transducers and condensing temperature thermistors.

    c. Shall provide a 5° F temperature difference between cooling and heating set points to meet ASHRAE 90.1 Energy Standard.

    d. Service run test capability.

    e. Shall accept input from a CO2 sensor (indoor) and provide demand ventilation control.

    f. Provide compressor minimum off time (5 minutes).

    g. Service diagnostic mode.

    h. Economizer control.

    i. Time delay relay.

    j. Integrated adjustable defrost cycle.

N. Safeties:

1. Unit shall incorporate a solid-state compressor lockout that provides optional reset capability at the space thermostat, should any of the following safety devices trip and shut off compressor:

    a. Compressor lockout protection provided for either internal or external overload.

b. Low-pressure protection.

c. Freeze protection (evaporator coil).

d. High-pressure protection (high pressure switch or internal).

e. Compressor reverse rotation protection.

f. Loss of charge protection.

g. Start assist on singe-phase units.

2. Supply-air sensor shall be located in the unit and detect both heating and cooling operation.

3. Phase Protection: Provide unit-mounted “SymCom,” or equal, Motor Saver three phase voltage monitor, model 201A or equal, adjustable voltage range for each unit, install per manufacturer's recommendations, mount in NEMA 3R enclosure if exposed to the weather.

a. Units shall provide the following features:

1) Low voltage fault trip and reset.

2) Voltage unbalance/phasing fault trip and reset.

3) High voltage fault trip and reset.

4) Transient Protection (Internal).

5) Automatic restart.

b. Provide each unit with 600V socket, “SymCom” model OT08, or equal.

O. Operating Characteristics:

1. Unit shall be capable of starting and running at 115° F ambient outdoor temperature per maximum load criteria of ARI Standards 210/240 or 340/360.

2. Unit with microprocessor or electro-mechanical controls shall operate in cooling down to an outdoor ambient temperature of 25° F.

3. Unit shall be provided with fan time delay to prevent cold air delivery in heating mode.

P. Electrical Requirements:

1. All unit power wiring shall enter unit cabinet at a single location. Both unit side and bottom power entry provisions shall be provided. Refer to Drawings schedule for thru-the-bottom power wiring requirement.

Q. Motors:

1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have line break thermal and current overload protection.

2. Evaporator fan motor shall have permanently lubricated, sealed bearings and inherent automatic-reset thermal overload protection or manual reset calibrated circuit breakers.

3. Totally enclosed condenser-fan motor shall have permanently lubricated, sealed bearings, and inherent automatic-reset thermal overload protection.

4. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

R. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Carrier Corporation.

2. York – Johnson Controls

3. Lennox

4. AAON

S. Provide the following additional features and equipment:

1. Roof Curb: formed galvanized steel with wood nailer strip capable of supporting entire unit weight. Provide 3 inch wide bottom flange.

2. Provide heavy-duty 18 gauge expanded metal coil guard grille to protect all surfaces of the condensing coil. Coil guard to by Micrometl, Canfab, or equal.

3. Modulating Power Exhaust Economizer: Micrometl, Canfab, or equal. Integrated type capable of simultaneous economizer and compressor operation.

a. Provide self-contained outdoor rooftop system, mounted directly to the return air compartment of the HVAC packaged equipment. Provide differential dry bulb economizer control system and a factory programmed, fully programmable variable frequency drive package controlled by a differential pressure transmitter, mounted directly to the return air compartment of the HVAC packaged equipment. Design the system to continuously maintain space pressure, and provide capability of introducing up to 100 percent outdoor air.

1) Economizer control system shall be certified as meeting the requirements for Fault Detection and Diagnostics (FDD) in the California Building Energy and Efficiency Standards.

b. Provide outside differential pressure tubing termination with hex style pneumatic filter-muffler, minimum filtration 40 microns, 53 SCFM maximum at 100 psi, as manufactured by McMaster-Carr, or equal.

c. Provide hinged cabinet access doors and include latches to provide a tool-less entry for servicing.

d. Provide door lock on the power exhaust cabinet to meet ETL safety requirements.

e. Outdoor air intake dampers shall be low leak not to exceed 3 percent at 1 inch wg pressure differential and include stainless steel side seal and neoprene edge seal. Arrange dampers to close upon loss of power.

f. Provide belt driven exhaust blowers, double inlet, forward-curved centrifugal type. Provide gravity backdraft damper at fan outlet.

g. Provide fully programmable factory programmed variable frequency drive (VFD) package for each fan, driven by 4 to 20 mA signal from a differential pressure transmitter. Pressure transmitters shall measure 0 - 0.1 in wg. Install room sensor tubing with sensor tube termination installed within the room.

1) Where direct digital controls are utilized, provide Belimo, or equal, damper actuator, complete with spring return and all controls required to make the system fully operational.

2) Where stand-alone controls are utilized, provide Belimo, or equal, damper actuator, complete with spring return and all controls, including logic module, required to make the system fully operational.

T. Replenish for a period of one year without cost to the Owner all refrigerant and oil required to maintain the proper levels.

U. Owner Training: Manufacturer shall provide two initial on-site 4-hour training sessions for Owners' maintenance personnel. Manufacturer shall provide one 4-hour follow-up training session to be scheduled by Owner within one year of the date of the final initial training session. Training session agenda shall be as follows:

1. First session: Equipment.

2. Second session: Controls.

3. Follow-up session: Agenda by Owner.

2.5 HEATING AND VENTILATING UNIT

A. Provide factory assembled packaged rooftop mounted, electrically controlled heating and make-up air unit, ETL or UL listed and labeled, consisting of cabinet, supply fan, 4" filters, and indirect-fired gas furnace. Provide all internal wiring, piping, controls and special features required prior to field startup. Design unit to conform to the following:

1. ANSI Z83.8/CSA 2.6.

2. NFPA 54.

3. ASHRAE 90.1.

4. Insulation, adhesive, and all materials exposed to airstream shall meet NFPA 90A requirements for flame spread and smoke generation.

5. Unit casing shall be capable of withstanding 1000-hour salt spray exposure per ASTM B117 (scribed specimen).

6. Roof curb shall be designed to conform to NRCA Standards.

B. Cabinet: Double-wall G90 galvanized steel panels, minimum 18 gauge, rigidly formed and supported by minimum 16 gauge galvanized steel channel base with rigging holes. Cabinet shall be fully weatherized for outdoor installation, and provided with the following:

1. Finish: Air-dried enamel.

2. Cabinet insulation: Minimum 1" thick fiberglass duct liner, complying with ASTM C 1071, Type II, applied on all unit sections.

3. Access Panels: Hinged, double-wall with cam-lock fasteners. Insulate access panels exposed to airstream equal to unit cabinet insulation. Provide access panels at furnace, fan motor, filter and control areas.

4. Provide with integral curb cap and matching roof curb. Roof curb shall be formed galvanized steel with wood nailer strip, capable of supporting entire unit weight. Provide 3 inch wide bottom flange.

C. Blower: Double width, double inlet centrifugal type fan, statically and dynamically balanced. Blower motor shall be single speed, open drip proof, and energy efficient. Motor bearings shall be permanently lubricated ball bearing or pillow block type. Blower and motor shall be vibration isolated.

1. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

2. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly. Linked blower belts will not be accepted.

D. Heating Section: CSA certified for use with natural gas, 80 percent minimum thermal efficiency. Heating section may be integral to blower cabinet or be provided as separate section. Provide with the following features:

1. Modulating gas valve, capable of turndown to minimum 25 percent of gas input value scheduled on Drawings.

2. Stainless steel burner assembly.

3. Combustion air vent fan: Direct drive centrifugal type.

4. Electronic discharge temperature controller. Control interface shall be LCD screen with indicating lights. Default display shall be actual discharge temperature.

5. Direct spark ignition with non-standing pilot.

6. 409 Stainless steel tubular heat exchanger.

7. Controls and Safeties: All burner controls factory wired to terminal blocks, complete with 24 V transformer. Provide the following:

a. High temperature limit control with automatic reset.

b. Ignition with 100 percent timed lockout.

c. Pressure switch to lock out gas valve on failure of combustion air blower.

d. Gas Train: Regulated, redundant, 24 V AC gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shut off, and manual shut off.

e. Purge-period timer shall automatically delay burner ignition and bypass low-limit control, and provide pre-purge and post-purge cycle.

E. Filter Section

1. Standard filter section shall accommodate 4 inch deep filters. Filters shall conform to the “Air Filters” Article in this Specification Section.

2. Filter section shall use standard size filters.

3. Velocity shall not exceed 550 FPM.

F. Mixing Box: Inlet air control shall allow for 100 percent OA and 100 percent return air with mixed air controller and warm-up (ASHRAE Cycle III). Standard configuration shall be bottom return with rear outside air intake. Provide galvanized outside air hood with bird screen and rain baffles. Omit outside air hood when evaporative cooling module is utilized. When economizer operation is indicated in the sequence of operations, provide dry bulb economizer controller.

G. Dampers:

1. Outdoor-Air and Return Air Damper: Galvanized steel, opposed-blade dampers with vinyl blade seals and stainless steel jamb seals.

2. Damper Operator: Direct coupled, multi-position electronic type with spring return or fully modulating electronic type as required by control sequence indicated on Drawings.

H. Downturn Plenum: Provide downturn plenum if required for vertical supply air discharge. See Drawings for unit air discharge configuration. Plenum shall be of materials, construction and finish equal to that described for unit cabinet.

I. Controls:

1. Factory-wired, fuse protected control transformer, connection for power supply and field-wired unit to remote control panel. Refer to Section 25 50 00, if included, and equipment schedule, sequence of operation and control diagram on Drawings for additional requirements.

2. When utilizing stand-alone thermostat controls: Manufacturer provided remote surface-mounted or recessed control panel shall contain potentiometer for setting minimum outside air quantity. Refer to Drawings for location and type of control panel. Remote control panel and potentiometer not required for direct digital control. Remote control panel shall have the following additional features:

a. Switches:

1) On-off-auto fan switch.

2) Heat-vent-cool switch.

b. Status lights:

1) Supply fan operation indicating light.

2) Blower on.

3) Heat/main valve on.

c. Thermostat with over-ride.

3. When utilizing direct digital control: Provide factory installed application-specific controller and damper actuators compatible with the direct digital control system. Unit manufacturer shall coordinate with controls contractor to ensure compatibility. Controller shall have the following functions:

a. Provide start and stop interface relay, and relay to notify DDC system of alarm condition. Provide the following alarms, as a minimum:

1) Supply fan status.

2) Heat status.

3) Freeze alarm.

b. Provide hardware interface or additional sensors as follows:

1) Room temperature.

2) Discharge air temperature.

3) Furnace operating.

4) Return air temperature.

5) Outdoor air temperature.

6) Heater output (0-100 percent).

7) Modulating damper output or VFD control (0-100 percent).

J. Evaporative Cooling Module: When scheduled on Drawings, provide evaporative cooling module with pump and water metering system. Evaporative cooling module shall be wired and mounted to the base unit at the factory. Provide the following:

1. Cabinet: 300 series stainless steel with finish equal to that described for unit cabinet. Cabinet may be galvanized steel when internal cooling module is of all stainless steel construction. Cabinet shall include louvered intake and 2 inch aluminum mesh filters.

2. Water reservoir: 300 series stainless steel. Overflow and drain connections in the drain pan bottom to be 1/2 inch diameter pipe or standard hose thread.

3. Pump: Submersible, centrifugal sump pump with inlet strainer, balancing valve located in pump discharge, thermally protected, fan cooled motor with moisture-proof windings.

4. Media: Media shall be 12 inch thick GlasDek by Munters Corporation, or equal, cross-fluted pad material of large fibers bonded together by inorganic, non-crystalline fillers and conforming to UL900, Class 2 rating. Pads will have less than .25 inches water column air pressure drop at 550 fpm face velocity when wet, and develop a saturation efficiency of not less than 90 percent.

5. Water hammer arrestor (furnished by piping contractor).

6. Antifreeze protection kit to lock-out evaporative cooling module and drain supply line at a manually selected outside air temperature.

7. Water Metering System:

a. Microprocessor-based water metering system: Provide timer, solenoid valve, and water distribution piping to apply the water supply to the media in response to outside air dry bulb and wet bulb temperatures. Remote thermostat shall open water supply valve to maintain dry-bulb temperature in space. Timer shall activate thermostat circuit.

K. Electrical: All unit power wiring shall enter the unit at a single location, standard side or alternate bottom. Single-point connection shall include evaporative cooler module. See unit schedule on Drawings for thru-the-bottom wiring requirement.

L. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include the following, or equal:

1. Greenheck Fan Corporation.

2. Reznor-Thomas & Betts Corporation; Mechanical Products Division.

M. Owner Training: Manufacturer shall provide one initial on-site 4-hour training session for Owners' maintenance personnel. Manufacturer shall provide one 2-hour follow-up training session to be scheduled by Owner within one year of the date of the final initial training session.

2.6 SPLIT SYSTEM HEAT PUMPS

A. General: Furnish and install split system air-to-air heat pump system, with R410A refrigerant, and complete with automatic controls. Equipment shall be shipped factory assembled, wired, tested, and ready for field connections.

B. Quality Assurance:

1. Unit shall be ETL or UL listed and labeled.

2. Unit shall be manufactured in a facility registered to ISO 9001:2000.

3. Unit shall be rated in accordance with ARI standard 210.

C. Delivery, Storage and Handling: Follow manufacturer's recommendations.

D. Heating/Cooling System: The total certified heating/cooling capacity shall not be less than scheduled. The compressor power input shall not exceed that of the unit specified.

E. Indoor Section: Wall mounted, ceiling surface mounted, or ceiling recessed mounted, as indicated on Drawings.

1. Cabinet:

a. Wall mounted: Molded white high strength plastic.

1) Provide wall mounted unit with factory mounting plate.

b. Ceiling surface mounted: Molded white high strength plastic with provision for outside air duct connection.

c. Ceiling recessed mounted: galvanized steel with provision for outside air duct connection.

2. Fans: Double inlet, forward curved, statically and dynamically balanced.

3. Fan Motor: Direct drive, permanently lubricated, with two or 4 speed operation for unit size scheduled on Drawings.

a. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

4. Air Outlet: With motorized horizontal and vertical vanes.

a. Wall and ceiling surface mounted units: Horizontal vane shall close air outlet upon unit shut-down.

5. Evaporator Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested.

6. Insulation: Interior surfaces exposed to the airstream shall be fully insulated.

F. Outdoor Section:

1. Casing: Galvanized steel plate, powder coated with acrylic or polyester.

2. Condenser Fan Grille: ABS plastic.

3. Fan and fan motor: Direct drive, totally enclosed, propeller type, permanently lubricated, horizontal discharge.

4. Compressor: Variable speed rotary type, with crankcase heater and accumulator. Compressor shall be capable of operating at 0 degrees F. Compressor mounted on vibration isolator pads.

5. Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested. Provide coil with integral metal guard.

G. Controls: Hard wired, microprocessor based, wall mounted controller with LCD display shall provide the following functions, as a minimum:

1. 7-day programmable timer.
2. Test and check functions.
3. Diagnostic functions.
4. Vane position control.
5. Fan speed adjustment.
6. Temperature adjustment.
7. Automatic restart.
8. Mode selection, including heat/auto/cool/dry/fan.
    a. Provide lockable enclosure for wall mounted controller.

H. Safeties: Shall include the following, as a minimum:

1. Five minute compressor anti-recycle timer.
2. High pressure protection.
3. Current and temperature sensing motor overload protection.

I. Filters: Provide manufacturers washable filters for indoor unit. Provide sufficient filters for four complete changes for each unit.

J. Service Access: All components, wiring, and inspection areas shall be completely accessible through removable panels.

K. Refrigerant Piping:

1. Provide factory pre-charged and sealed line set piping, length to suit the location of equipment. Tubing sizes shall be in accordance with manufacturers written instructions.
2. Provide refrigeration piping in accordance with Article, Refrigerant Piping, in this Section.

L. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Mitsubishi Electric Corporation.
2. Carrier / Toshiba Corporation.
3. Daikin

M. Owner Training: Manufacturer shall provide one on-site 2-hour training session for Owners' maintenance personnel.

2.7 SPLIT SYSTEM AC UNIT

A. General: Furnish and install split system air conditioner, with R410A refrigerant, and complete with automatic controls. Equipment shall be shipped factory assembled, wired, tested, and ready for field connections.

B. Quality Assurance:

1. Unit shall be ETL or UL listed and labeled.

2. Unit shall be manufactured in a facility registered to ISO 9001:2000.

3. Unit shall be rated in accordance with ARI standard 210.

C. Delivery, Storage and Handling: Follow manufacturer's recommendations.

D. Cooling System: The total certified cooling capacity shall not be less than scheduled. The compressor power input shall not exceed that of the unit specified.

E. Indoor Section: Wall mounted, ceiling surface mounted, or ceiling recessed mounted, as indicated on Drawings.

1. Cabinet:

a. Wall mounted: Molded white high strength plastic.

1) Provide wall mounted unit with factory mounting plate.

b. Ceiling surface mounted: Molded white high strength plastic with provision for outside air duct connection.

c. Ceiling recessed mounted: galvanized steel with provision for outside air duct connection.

2. Fans: Double inlet, forward curved, statically and dynamically balanced.

3. Fan Motor: Direct drive, permanently lubricated, with two or 4 speed operation for unit size scheduled on Drawings.

a. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

4. Air Outlet: With motorized horizontal and vertical vanes.

a. Wall and ceiling surface mounted units: Horizontal vane shall close air outlet upon unit shut-down.

5. Evaporator Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested.

6. Insulation: Interior surfaces exposed to the airstream shall be fully insulated.

F. Outdoor Section:

1. Casing: Galvanized steel plate, powder coated with acrylic or polyester.

2. Condenser Fan Grille: ABS plastic.

3. Fan and fan motor: Direct drive, totally enclosed, propeller type, permanently lubricated, horizontal discharge.

4. Compressor: Variable speed rotary type, with crankcase heater and accumulator. Compressor shall be capable of operating at 0 degrees F. Compressor mounted on vibration isolator pads.

5. Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested. Provide coil with integral metal guard.

G. Controls: Hard wired, microprocessor based, wall mounted controller with LCD display shall provide the following functions, as a minimum:

1. 7-day programmable timer.

2. Test and check functions.

3. Diagnostic functions.

4. Vane position control.

5. Fan speed adjustment.

6. Temperature adjustment.

7. Automatic restart.

8. Mode selection, including cool/dry/fan.

a. Provide lockable enclosure for wall mounted controller.

H. Safeties: Shall include the following, as a minimum:

1. Five minute compressor anti-recycle timer.

2. High pressure protection.

3. Current and temperature sensing motor overload protection.

I. Filters: Provide 1 inch thick fiberglass throwaway filters with cardboard holding frames for indoor unit. Provide sufficient filters for four complete changes for each unit.

J. Service Access: All components, wiring, and inspection areas shall be completely accessible through removable panels.

K. Refrigerant Piping:

1. Provide factory pre-charged and sealed line set piping, length to suit the location of equipment. Tubing sizes shall be in accordance with manufacturers written instructions.

2. Provide refrigeration piping in accordance with Article, Refrigerant Piping, in this Section.

L. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Mitsubishi Electric Corporation.

2. Carrier Corporation.

M. Owner Training: Manufacturer shall provide one on-site 2-hour training session for Owners' maintenance personnel.

2.8 VARIABLE REFRIGERANT FLOW - SPLIT SYSTEM HEAT PUMPS – HEAT RECOVERY TYPE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Mitsubishi w/diamond panel integration (Basis of Design) w/BAcnet integration to Johnson Controls

2. Daikin w/BAcnet integration to Johnson Controls

3. Hitachi w/BAcnet integration to Johnson Controls

B. Indoor Units

1. General:

a. Galvanized steel casing.

b. Ducted, ceiling-recessed, or in-room units per Drawings schedule. Available styles shall include:

1) Concealed (ducted) units:

a) Horizontal/Vertical air handling unit for closet or above-ceiling installation.

b) Ceiling concealed.

c) Ceiling concealed, with high-static option.

2) Recessed Units:

a) Ceiling-recessed units: One-, two-, and four-way throw configurations.

b) Floor-standing, recessed.

3) In-room units:

a) Ceiling-suspended.

b) Wall-mounted.

c) Floor-standing.

c. Factory assembled and tested with factory wiring, piping, expansion valve, control circuit board, and fan motor. Units shall have, as a minimum, the following functions:

1) Self-diagnostic function.

2) Auto restart function.

3) Auto changeover function.

4) Emergency operation function.

5) 3-minute time delay shall provide minimum 3 minute run time for cooling and heating.

d. Indoor unit and refrigerant pipes shall be charged with dehydrated air prior to shipment from the factory.

e. The indoor units shall be equipped with a return air thermistor.

2. Unit Cabinet:

a. The cabinet shall be insulated with foamed polystyrene and polyethylene insulation.

3. Fan:

a. The fan shall be direct-drive type, statically and dynamically balanced impeller with multiple high and low fan speeds. Auto fan setting shall automatically adjust fan speed.

b. The fan motor shall be thermally protected.

c. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

d. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

e. Ceiling recessed and wall-mounted units shall have motorized louvers to direct airflow in up and down directions, and manually adjusted vanes for side-to-side adjustment of airflow direction.

f. Ceiling suspended units shall have motorized guide vanes to vary airflow direction.

g. All units shall be provided with a condensate drain pan below the coil. Drain pans shall have primary and overflow drains.

h. Ceiling recessed units shall have an integral condensate pump. Refer to Drawings schedule for additional condensate pump requirements.

4. Coil:

a. Coils shall be aluminum fins bonded to internally grooved copper tubes. Fins shall have corrosion-resistant coating.

b. The coils shall be pressure tested at the factory.

c. Unit shall be provided with ball-type refrigerant service valves at each refrigerant piping connection.

d. A condensate pan and drain connections shall be provided under the coil. Provide overflow cutoff switch to disable unit during overflow condition.

5. Filters:

a. Provide indoor units manufactured to accept washable filter media with two sets for each unit.

b. Refer to Drawings schedule, and article, Filters, in this Section for filter requirements for ducted, above-ceiling units incorporating mixing boxes.

6. Controls:

a. Units shall have controls provided by the manufacturer to perform input functions necessary to operate the system.

b. Operating modes shall include Auto Changeover (heat recovery systems only), Heating, Cooling, Dry, and Fan Only.

c. Units shall be compatible with a BMS system via optional LonWorks or BACnet gateways.

d. Units incorporating mixing boxes for economizer operation shall be furnished with economizer control system certified as meeting the requirements for Fault Detection and Diagnostics (FDD) in the California Building Energy and Efficiency Standards.

C. Outdoor Condensing Units:

1. General:

a. Condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves (when required by manufacturer), 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant accumulator and regulator.

b. The following safety devices shall be included as part of the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, over- and under-current protection, phase failure and phase reversal protection, fusible plug or pressure relief valve, and crankcase heater..

c. All refrigerant lines shall be individually insulated between the condensing units and indoor units. .

d. The system will automatically restart operation after a power failure without loss of settings.

e. The condensing units shall be modular in design and allow for side-by-side installation with minimum spacing. Provide kit for field piping between connected condensing units. Refer to Drawings schedules and diagrams for connected units.

f. To ensure the liquid refrigerant does not flash when supplying to indoor units, the circuit shall be provided with a sub-cooling feature.

g. Oil recovery cycle shall be automatic occurring 2 hours after start of operation, and thereafter every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.

h. The condensing unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.

1) Provide condensing unit with low ambient kit when scheduled on Drawings. Low ambient kit components shall be furnished with NEMA 4x rated control box for outdoor installation.

2. Unit Cabinet:

a. The condensing unit cabinet shall be weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel or powder coat finish.

3. Fan:

a. The condensing unit shall consist of one or more direct-drive, vertical discharge propeller fans with blades constructed of thermoplastic polymer material.

b. The condensing unit fan motor shall be variable-speed digitally commutating (DC) type. Fan motor dipswitch shall allow increase of external static pressure setting.

c. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted on vibration isolators.

d. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

4. Condenser Coil:

a. Coils shall be aluminum fins bonded to internally grooved copper tubes. Fins shall have corrosion-resistant coating.

b. The coils shall be pressure tested at the factory.

c. Unit shall be provided with ball-type refrigerant service valves at each refrigerant piping connection.

d. Condensing unit cabinet shall be provided with metal coil guard.

5. Compressor:

a. The scroll compressors shall be variable speed pulse-width inverter (PVM inverter) controlled type, hermetically sealed, which shall vary the compressor speed to follow fluctuations in total cooling and heating load, determined by the suction gas pressure as measured in the condensing unit.

1) The inverter driven compressor motor in each condensing unit shall be the reluctance DC (digitally commutating) type.

b. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

c. Oil separators shall be provided as part of the compressor module together with an intelligent oil management system.

d. The compressor shall be isolated to avoid the transmission of vibration.

e. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity.

f. Multiple compressor operation sequencing: When multiple condenser modules are combined, operation hours of each compressor shall be balanced by means of a duty cycling function, enabling sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.

g. Refrigerant shall be R410a.

D. Indoor Heat Recovery Controllers: Two- or three-pipe refrigerant control units to match outdoor condensing unit configuration. Heat recovery units shall be installed between outdoor condensing units and indoor zone-conditioning units. Indoor heat recovery unit shall operate to remove heat from zones requiring cooling, and distribute that heat to zones requiring heating. Refer to Drawings for unit locations. Refer to Drawings schedules and details for unit configuration and electrical requirements.

E. Refrigerant Piping:

1. All refrigerant lines shall be individually insulated between the condensing units and indoor units.

2. For interconnecting piping between outdoor and indoor equipment, refer to Article, Refrigeration Pipe and Fittings, in this Section.

F. System Controls:

1. General: The controls network shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to a Building Management Systems via BACnet® and/or LonWorks®.

2. For additional information, Refer to Section 23 09 23, Direct Digital Control System for HVAC.

3. Programmable Local Remote Controller: The programmable local remote controller shall be capable of controlling a minimum of 16 indoor units serving a single zone, and of operation with or without a central controller. Controller shall have the following minimum functions:

    a. On/Off.

    b. Operating mode (cool, heat, auto, dry, and fan, depending on selected system type).

    c. Temperature setting.

    d. Fan speed setting.

    e. Air swing settings.

    f. Room temperature and humidity display.

    g. Occupancy sensor capable.

    h. Schedule operations.

    i. Allow/Prohibit local remote control functions.

    j. Unit level error code display.

    k. Test run.

    l. Set temperature range limit.

    m. Override of scheduled functions for indoor unit groups.

    n. Lock out of On/Off, Mode, Set Temp., Hold-button, and Air Direction.

4. Centralized Controller: The controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, error email notification, online maintenance tool and malfunction monitoring. The controller shall have basic operation controls which can be applied to an individual indoor unit, a group of indoor units, or all indoor units. (cool, heat, auto, dry, and fan)The central controller shall be able to enable or disable operation of local remote controllers via a PC. Controller shall have the following minimum functions:

    a. On/Off.

    b. Operating mode (cool, heat, auto, dry, and fan, depending on selected system type).

    c. Temperature setting.

    d. Fan speed setting.

    e. Air swing settings.

    f. Room temperature display.

    g. Schedule operations.

    h. Morning warm-up/cool-down.

    i. Night setback setting.

    j. Allow/Prohibit local remote control functions.

    k. Unit level error code display.

l. External input/output.

m. PC data back-up.

5. BACnet® and/or LonWorks® Gateway: Gateway to allow connection to Energy Management Systems shall allow changes to the following, as a minimum:

a. On/Off.

b. Temperature setting.

c. Alarm.

d. Operating mode.

e. Fan speed setting.

f. Allow/Prohibit local remote control functions.

g. High/Low limit setback temperature (heat recovery systems only).

h. Air direction/swing settings.

6. Web browser: The controls network shall allow multiple individual users to monitor and control user defined zones via a network PC web browser.

G. Owner Training: Manufacturer shall provide one on-site 8-hour training session for Owners' maintenance personnel. 8-hour training shall include instruction in use of equipment manufacturer's service tool.

2.9 HIGH EFFICIENCY FURNACE UNIT

A. Provide high efficiency multiple-speed condensing furnace/blower unit for upflow, downflow or horizontal application as indicated on the Drawings. Design unit to conform to the following:

1. California Air Quality Management District emission requirements.

2. ANSI Z 21.47/CSA 2.3 design standard for gas-fired central furnaces.

B. Furnace unit shall have the following certifications:

1. Third party certification by CSA International to current ANSI Z 21.47/CSA 2.3 design standard for gas-fired central furnaces.

2. CSA Blue Star® and Blue Flame® labeled.

3. Efficiency testing per current DOE test procedure as listed in the Federal Register.

4. Federal Trade Commission Energy Guide efficiency labeled.

5. GAMA Consumers' Directory of Certified Efficiency Ratings listed.

C. Unit shall be manufactured in a facility registered to ISO 9001:2000.

D. Cabinet:

1. Pre-painted galvanized steel, minimum .030 inches thickness.

2. Acoustically insulated blower section.

3. Removable bottom closure panel for bottom return air configuration.

E. Fans and Motors:

1. Centrifugal supply air blower shall be constructed of galvanized steel, statically and dynamically balanced.

2. Blower motor shall be direct drive variable speed ECM type, with sealed permanently lubricated ball bearings.

3. Inducer motor shall be direct drive variable speed ECM type, with sealed permanently lubricated ball bearings.

F. Heating Section:

1. Primary heat exchanger shall be 20 gauge corrosion resistant aluminized steel of fold-and-crimp sectional design, with Monoport inshot burners and redundant gas valve.

2. Secondary heat exchanger shall be polypropylene laminated steel of fold-and-crimp design.

3. Heat exchanger section shall be insulated with foil-faced insulation.

4. Line voltage ignitor.

5. Sealed combustion system.

G. Filters:

1. Standard filter section shall accommodate 4 inch deep filters. Filters shall conform to the “Air Filters” Article in this Specification Section.

2. When Drawings indicate contractor-fabricated plenum containing filters, plenum shall accommodate 4 inch deep filters. Filters shall conform to the “Air Filters” Article in this Specification Section.

3. Filter section shall use standard size filters.

H. Controls:

1. Fused microprocessor based control board with diagnostic LED and self-test capability.

2. Unit blower shall operate at continuous speed only, adjust to achieve the airflow scheduled on the Drawings. Other blower speed settings shall be locked out.

I. Safeties:

1. Provide pressure switch for proving flow of flue products and manual reset over-temperature switch.

2. Provide with blower access panel safety interlock switch.

J. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Carrier Corporation.

2. York – Johnson Controls

3. Lennox

K. Provide with mixed air plenum with filter rack and return and outside air dampers, arranged as indicated on Drawings.

1. Where economizer operation is indicated on Drawings, provide differential dry-bulb economizer control system, certified as meeting the requirements for Fault Detection and Diagnostics (FDD) in the California Building Energy and Efficiency Standards.

L. Provide condensate pump, arranged as indicated on Drawings, for removal of condensate from furnace units.

M. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.10 AIR COOLED CONDENSING UNIT

A. Provide outdoor-mounted, factory assembled, single piece, air-cooled, split-system air conditioner unit suitable for ground or rooftop installation, rated in accordance with ARI Standard 210, and UL or ETL listed and labeled. Provide refrigerant charge R-410A, all internal wiring, piping, controls, compressor, and special features required prior to field start-up. Design unit to conform to the following:

1. ANSI/ASHRAE latest edition.

2. NEC latest edition.

3. Unit cabinet to be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test.

4. Unit shall be constructed in accordance with UL standards.

B. Unit shall be certified for capacity and efficiency, and listed in the latest ARI directory.

C. Unit shall be manufactured in a facility registered to ISO 9001:2000.

D. Unit shall be Energy Star Qualified.

E. Provide unit with 5 year limited parts warranty.

F. Cabinet:

1. Unit cabinet constructed of galvanized steel, bonderized, and coated with powder coat paint.

G. Fans:

1. Direct-drive propeller type condenser fan, discharging air vertically.

2. Totally enclosed condenser fan motors, 1-phase type with Class B insulation and permanently lubricated bearings, and corrosion resistant shafts.

3. Condenser fan openings equipped with PVC-coated steel wire safety guards.

4. Statically and dynamically balanced fan blades.

H. Compressor:

1. Hermetically sealed compressor mounted on rubber vibration isolators.

2. Compressor with sound insulator.

I. Refrigeration Components:

1. Refrigerant circuit to include liquid and vapor line shut-off valves with sweat connections.

2. System charge of R-410A refrigerant and compressor oil.

3. Unit to be equipped with factory-supplied high-pressure switch, low pressure switch, and filter drier.

4. Provide unit with manufacturer's refrigerant line set.

5. Provide refrigeration piping in accordance with Article, Refrigerant Piping, in this Section.

J. Condenser Coil:

1. Air-cooled condenser coil constructed of aluminum fins mechanically bonded to copper tubes.

2. Coils shall be leak and pressure tested.

K. Electrical Requirements:

1. Unit shall have single point power connection.

2. Provide unit with 24V control circuit.

L. Operating Characteristics:

1. Unit shall be capable of starting and running a 115 degrees F ambient outdoor temperature per maximum load criteria of ARI Standard 210.

2. Compressor with standard controls shall be capable of operation down to 55 degrees F ambient outdoor temperature.

M. Provide the following additional components and features:

1. Provide evaporator freeze thermostat, winter start control, compressor start assist capacitor and relay, low ambient controller, and ball bearing fan motor.

2. Provide expanded metal coil guard for all sides of the air-cooled condensing unit. Coil guard shall be as manufactured by MicroMetl, Can-Fab, or equal.

N. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Carrier Corporation.

2. Lennox

O. Owner Training: Manufacturer shall provide one on-site 1-hour training sessions for Owners' maintenance personnel.

2.11 COOLING COIL

A. Provide direct expansion encased cooling coil.

1. Install encased coil to operate properly in vertical or horizontal position as required. Construct coil with aluminum plate fins mechanically bonded in non-ferrous tubing with all joints brazed ultrasonically. Coil shall have factory-installed refrigerant metering device, refrigerant line fittings which permit mechanical connections, and condensate pan with primary and auxiliary drain connections.

2. Construct casings of galvanneal steel, bonderize, insulate, and finish with baked enamel.

2.12 REFRIGERATION PIPE AND FITTINGS

A. Refrigeration gas and liquid piping shall be type ACR hard drawn copper tubing, cleaned and capped in accordance with ASTM B280, with wrought copper fittings. All joints shall be brazed with Sil-fos under nitrogen purge. Relief valve discharge piping shall be full size of relief discharge port.

1. Manufactured, pre-charged and pre-insulated refrigerant line-set refrigerant piping may be utilized at Contractor's discretion.

a. VRF Systems: Use of manufactured, pre-charged and pre-insulated refrigerant line-set refrigerant piping between outdoor condensing units and indoor heat recovery controllers, or distribution headers and tees is not allowed. When system manufacturer's installation instructions allow use of refrigerant line-set piping between indoor heat recovery controllers, or distribution headers and tees, and air terminal devices, follow instructions for allowable pipe size range and support to avoid forming traps in the piping.

B. Variable Refrigerant Flow Heat Pump Systems Fittings:

1. For systems manufacturers requiring engineered, pre-assembled headers and branch fittings, Contractor shall obtain such fittings from system manufacturer. Fittings shall be suitable for system type and configuration.

2. For systems manufacturers not requiring engineered, pre-assembled headers and branch fittings, Contractor shall furnish fittings complying with manufacturer's requirements.

C. Refrigeration Piping Specialties: Furnish and install Superior, Sporlan, Alco, Henry, or equal, stop valves, solenoid valves, adjustable thermal expansion valves, sight glass, flexible connection, charging valve, and drier with valve bypass in the liquid lines and Superior DFN shell and cartridge suction line filter sized 2-1/2 times tonnage.

1. Install only those refrigeration piping specialties recommended by manufacturer of specific installed equipment.

2.13 REFRIGERANT ACCESS VALVE LOCKING CAPS

A. Each refrigerant circuit access valve located outside buildings, including valves located on roofs, shall be provided with a locking cap. Caps shall be of metal construction, with threaded brass inserts. Caps shall be color-coded according to ASHRAE standards for R22 and R410A refrigerant gasses, universal color for other refrigerant gasses. Caps shall be removable only with cap manufacturer's handheld tool.

1. Provide minimum of two (2) cap removal tools for every ten (10) air conditioning units or other systems containing refrigerant installed under this Project.

2.14 ELECTRIC RADIANT CEILING PANELS

A. Provide radiant ceiling panels in locations as indicated and with capacities, style, and accessories as scheduled. The panels shall be UL or ETL listed.

B. Construct panels using 24 gauge galvanized steel back overlapping and riveted to a 22 gauge galvanized steel front. Provide carbon (graphite) element and provide surface of multi-faceted crystalline type which will demonstrate a watt density of 1.00 watt per square foot at a distance of six feet down from the center of the panel, with a rated input of 95 watts per square foot with an average surface temperature of not more than 200 degrees F.

C. Panels shall come with a five year warranty.

D. Provide an extruded aluminum support frame, with 0.070 inch thick support brackets. Install brackets, frame and panels in accordance with manufacturers printed instructions.

E. Provide a heavy-duty double line break thermostat, modified with blank front panel and 50 degrees F to 90 degrees F range.

F. Provide locking cover for each thermostat.

G. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Aztec Radiant Heating.

2.15 FANS

A. All fans shall be Air Moving and Control Association Inc. (AMCA) labeled.

B. Provide self-aligning, enclosed ball bearings, accessible for lubrication unless specified otherwise.

C. Provide variable speed switch for all direct drive fans.

D. Roof Mounted:

1. Direct or V-belt Drive: Provide one-piece heavy-duty ventilator housings, one piece heavy gauge spun aluminum construction, with weatherproof assembly and integral weather shield. Mount ventilators on curbs furnished by the fan manufacturer. Install with fan assembly level.

2. Fan wheels shall be centrifugal design, statically and dynamically balanced. Tip speed, rpm and motor horsepower shall not exceed listing in manufacturer's catalog for unit specified.

3. Fans shall have integral factory formed base and one piece spinning without welding. Housings shall be provided with wiring channel and are to be of the direct discharge design. Motor and fan assembly shall be on vibration isolating mounts. Fans shall have capacity, speeds and motor sizes as shown.

4. Provide the following accessories:

a. Gravity backdraft dampers.

b. Aluminum bird screen with a minimum of 85 percent free area.

c. Adjustable motor pulley.

d. Laboratory fume hood exhaust fans shall be Keysite coated.

e. Provide grease collection tray for kitchen exhaust fans.

f. Provide ventilated roof curb for kitchen exhaust fans where exhaust duct is mounted within rated shaft.

g. Provide hinge kit for kitchen hood exhaust fans.

E. In-Line Propeller Fans:

1. Heavy-duty propeller type with belt or direct drive as specified. Blades shall be individually mounted to wheel.

2. Provide sloped roof or flat roof type roof cap, or wall cap to suit the location indicated on the Drawings.

F. In-Line Centrifugal Fans:

1. Centrifugal fan with airfoil blades, aluminum or steel housing, externally mounted belt-drive motor, external lube tubes, integral support brackets.

2. Provide sloped roof or flat roof type roof cap, or wall cap to suit the location indicated on the Drawings.

G. Ceiling Mounted Fans:

1. Acoustic lined cabinet, built-in back draft damper, vibration isolated fan and motor, variable speed switch.

2. Provide sloped roof or flat roof type roof cap, or wall cap to suit the location indicated on the Drawings.

H. Fan Drives:

1. Drive Design: The design horsepower rating of each drive shall be at least 1.5 times, single belt drives 2 times, the nameplate rating of the motor with proper allowances for sheave diameters, speed ratio, arcs of contact and belt length.

2. Provide variable speed drives, Dayco, Browning, Woods, or equal. Allow for replacement of fan and motor drives and belts as required to suit the balance requirements of the project.

3. Select variable speed drives to allow an increase or decrease of minimum of ten percent of design fan speed.

I. Motors:

1. Motors of 25 HP and less shall have adjustable pitch sheaves; sheaves on motors above 25 HP may be non-adjustable. Change, at no extra cost to Owner, the non-adjustable sheaves to obtain desired air quantities.

2. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.

J. Sheaves: Sheaves shall be cast or fabricated, bored to size or bushed with fully split tapered bushings to fit properly on the shafts. All sheaves shall be secured with keys and set screws.

K. Belts:

1. All belts shall be furnished in matched sets.

2. Belts shall be within 1 degree 30 minutes of true alignment in all cases.

L. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Greenheck Fan Corporation.

2. Loren Cook Company.

3. PennBarry.

M. Fly Fan (Air Curtain)

1. Manufacturer's standard, high velocity, non-recirculating type. Units for kitchens or food storage shall comply with NSF 37.

2. Casing: Sheet metal or polycarbonate plastic. Provide internal or external vibration isolation to effectively prevent transmission of vibration and noise from units to building structure. Units shall completely house all parts and have manufacturer's standard finish coating.

3. Fans: Ruggedly constructed, statically and dynamically balanced. Noise level shall not exceed 77 dBA measured at 5 feet distance.

4. Air Discharge Outlet Nozzle: Cover full width of door opening. Fan discharge ducts, plenum, flow control vanes and nozzles shall provide a uniform distribution of air over entire length of door. Provide adjustable volume and directional control.

5. Heating Coil: Provide electric heating coil. Maximum discharge air temperature shall be 120 degrees F.

6. Controls: Provide on-off door operated switch. The "on-off" switch circuit shall close to start fan motors when door starts to open and open when the door reaches closed position. A local disconnect switch for each fan motor shall be provided and shall be mounted to be accessible without use of ladder.

7. Motors: Provide heavy-duty totally enclosed fan motor, sealed ball bearings, resilient mounting, automatic thermal overload switch, UL listed. Provide weather protection for motor and electrical equipment.

8. Available Manufacturers: Subject to compliance with requirements, manufacturers offering air doors / fly fans which may be incorporated in the work include the following, or equal:

   a. Mars Air Products; Mars Air Door Division.

   b. Berner International.

   c. Fantech.

N. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.16 KITCHEN EXHAUST HOOD – TYPE 1

A. Furnish packaged pre-manufactured ventilator, constructed of stainless steel, complete with baffles and lights. Unit shall be equal to that specified in equipment schedule.

B. Each ventilator shall be a high velocity type grease extractor.

1. Centrifugal grease extraction efficiency of 90 percent to be accomplished without the use of filters, cartridges, or constant running water. (Verify with hood selected)

C. Compensating ventilators shall not be of the short-circuiting type. Furnish integral front face discharge for up to 80 percent make-up air of the exhausted air.

D. Construction: The ventilator shall be of all stainless steel construction not less than 18 gauge, Type 304, number 4 finish. The assembly at joints and seams shall be liquid tight and all exposed external welds shall be ground and polished to match the original finish of the metal. All unexposed surfaces shall be constructed of minimum 18 gauge galvanized steel, including but not limited to duct, plenums, framing and brackets. Provide stainless steel closure panels as required for a complete finish, satisfactory to the Architect.

E. Filters: Grease Filters shall be manufactured in accordance with UL 1046.

F. Approvals: Ventilators to be listed or recognized by ICBO (refer to Research Report 2064), NSF, UL and in accordance with all recommendations of NFPA's Standard #96.

G. Fire Suppression System:

1. Fire suppression system shall be listed and labeled as conforming to NFPA 17A and UL 300, current edition.

2. Furnish wet chemical system to protect the hood, exhaust duct and cooking appliances against fire. The system shall be installed by an authorized distributor in accordance with NFPA 96, NFPA 17A, UL listings, and the requirements of authorities having jurisdiction.

3. The system shall be manually operable at the release. The system shall contain a fusible link series detector system for automatic actuation of the system. Actuation of the system shall provide automatic mechanical gas valve line shutoff. Provide manual operation, with local actuation at the tank enclosure.

4. System shall consist of suppressant, pressurizing cartridge, Schedule 40 piping and nozzles. Provide system with fresh cartridge. Provide stainless steel enclosure for cartridge, regulated release mechanism, regulator and all other material required for operation of the system.

5. System shall be Ansul R102, Kidde, or equal. Provide multiple system if required.

6. Upon completion of the installation of the fire suppression system a test of the system shall be conducted in the presence of the enforcing agency.

H. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.17 KITCHEN EXHAUST HOOD – TYPE 2

A. General:

1. Furnish ventilator hood of size and qualities as indicated on plans, the ventilator shall be of all stainless steel construction not less than 18 gauge, Type 304, Number 4 finish.

2. Furnish condensate hoods with full perimeter welded condensate collecting gutter with 1/2 inch NPT stainless steel drain fitting.

B. Approvals: Ventilators to be listed or recognized by ICBO (Research Report 2064), NSF, UL, and in accordance with all recommendations of NFPA-96.

C. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.18 KILN EXHAUST HOOD SYSTEM

A. Furnish Vent-A-Kiln, or equal, overhead, adjustable fume exhaust system at each kiln, with size as indicated on drawings, and as recommended by manufacturer. Unit shall be furnished with two speed motor and blower, spun aluminum hood, overhead counterweight pulley system, venting kit with flexible hose, and all clamps and mounting plates required for complete system operation.

B. Provide three year warranty on all parts of the system.

2.19 WELDING EXHAUST SYSTEM

A. Furnish Plymovent, Car-Mon, Nederman, or equal welding exhaust system with weld proof flexible tubing and receptors. Exhaust fan and exhaust apparatus to be by same manufacturer. Ductwork shall be United McGill Corp Sheet Metal Division, Air Systems, Inc., or equal.

B. Owner Training: Manufacturer shall provide one on-site 4-hour training session for Owners' maintenance personnel.

2.20 RELIEF AND INTAKE VENTS

A. Galvanized steel housing with 1/2 inch mesh screen, counterbalanced backdraft damper and matching prefabricated curb. Omit backdraft damper on intake vents. Provide pitched roof curb for relief vents, and install with backdraft damper level.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Greenheck Fan Corporation.

2. Lauren Cook Company.

3. PennBarry.

4. American Coolair Corporation.

2.21 LOUVERS

A. Louvers shall be minimum 16 gauge steel with Bonderite and Epon gray primer and 1/2 inch square mesh, 16 gauge galvanized steel screen on the inside. Louvers shall be Airolite #609, Arrow United Industries, or equal, with 4 inch louver depth.

2.22 AIR INLETS AND OUTLETS

A. Except as otherwise indicated, provide manufacturer's standard inlets and outlets where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Ceiling, wall or floor Compatibility: Provide inlets and outlets with border styles that are compatible with adjacent ceiling, wall or floor systems, and that are specifically manufactured to fit into ceiling, wall or floor module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems that will contain each type of air outlet and inlet.

C. Refer to Schedule on Mechanical Drawings for details of inlets and outlets to be used.

2.23 AIR TERMINAL UNITS

A. Shutoff, Single-Duct Air Terminal Units:

1. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

2. Casing: 0.034-inch-thick galvanized steel, single wall.

a. Casing liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard.".

1) Minimum Thickness: 1/2 inch

2) Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

3) Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4) Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a) Adhesive VOC Content: 80 g/L or less.

b) Adhesive shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

c)

3. Inlets and Outlets: Air inlet shall be round or rectangular stub connection or S-slip and drive connections for duct attachment. Air outlet shall be S-slip and drive connections, size matching inlet size.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

6. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

a. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg 6-inch wg inlet static pressure.

7. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

8. Controls:

a. Air terminal units shall be furnished with damper and multipoint velocity sensor. Damper actuator, pressure-independent, variable-air-volume (VAV) or constant-air-volume (CAV) controller with electronic airflow transducer, and room sensor are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC.

b. Control devices shall be compatible with temperature controls system

1) Electronic Damper Actuator: 24 V, powered open, spring return.

2) Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) or constant-air-volume (CAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

a) Occupied and unoccupied operating mode.

b) Remote reset of airflow or temperature set points.

c) Adjusting and monitoring with portable terminal.

d) Communication with temperature-control system.

3) Room Sensor: Wall mounted, with the following features:

a) Digital display of sensed temperature.

b) Local temperature setpoint adjustment. Capable of manual override through control system operator.

c) Local override to turn HVAC on. Capable of manual override through control system operator.

d) Access for connection of portable operator terminal.

9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

a. Price Limited.

b. Titus.

c. Johnson Controls, Inc.

2.24 AIR FILTERS

A. Provide MERV 13 disposable pleated media type. Refer to specific equipment Articles for filter depth and for exceptions to this specification. Filters shall conform to the following:

1. Standards:

a. ASHRAE Standard 52.2-2007.

b. Underwriters Laboratories: U.L. 900, Class 2.

2. Construction:

a. Media: Synthetic or cotton-synthetic blend with radial pleats.

b. Media Frame: High wet-strength beverage board.

c. Media Support: Welded wire or expanded metal grid bonded to air leaving side of the media.

3. Performance: 4” deep filter shall have a maximum initial air resistance of 0.31 inches w.g.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Camfil Farr, Inc., model 30/30.

2. Flanders Corporation, model 40 LPD.

C. Temporary (Construction Period) Filters:

1. Install new temporary filters in all units that have filter systems installed. Temporary filters shall match the permanent filters that are specified for the units. Replace filters as needed, in accordance with manufacturer’s directions, in order to provide protection for the unit prior to occupancy by the Owner.

2. If air handling units are operated during construction of the project, install temporary filters directly over each return air inlet. Filters shall match the permanent filters that are specified for the units. Select size of filter to completely cover the frame of the return air inlet, and tape filters firmly in place to eliminate any construction debris from entering the duct system or unit. Remove the temporary filters upon completion of the work, and repair all damaged paintwork.

D. Spare Filters:

1. Furnish two new, complete sets of filter cartridges for each filter bank on completion and acceptance of the work. Install one set of filters in units (prior to final air balance). Provide units designed to accommodate washable, permanent filters with one washable, permanent filter.

2.25 DAMPERS

A. Backdraft Dampers: Ruskin CBD2, counterbalanced, Nailer Industries, or equal.

B. Manual Air and Balance Dampers: Provide dampers of single blade type or multi-blade type constructed in accordance with SMACNA, "HVAC Duct Construction Standards," except as noted herein.

1. Rectangular Ductwork:

a. Single damper blades may be used in ducts up to 10 inches in height. Dampers shall be 16 gauge minimum. Provide self-locking regulators, equal to Ventlok 641. Provide end bearings equal to Ventlok 607 at each damper. Provide continuous solid 3/8 inch square shafts.

b. Multiple blade dampers shall be equal to Ruskin CD35 Standard Control Damper. Maximum width for multiple damper blades for use in rectangular duct shall not exceed 6 inches.

c. Where duct velocity may be expected to exceed 1500 fpm, provide Ruskin CD-50, or equal, low leakage dampers with airfoil blades.

2. Round Ductwork:

a. Single damper blades may be used in ducts up to 12 inches in diameter. Provide multiple blade opposed blade dampers, with connected linkage, for ductwork larger than 12 inches in diameter.

b. Damper blades for round ductwork shall be 20 gauge steel for ducts up to 12 inches diameter and 16 gauge steel for dampers larger than 12 inches damper. Provide self-locking regulators, equal to Ventlok 641, Durodyne, or equal for operation of dampers. Provide end bearings equal to Ventlok 607 and provide continuous solid 3/8 inch square shafts.

3. Where ductwork is externally insulated, provide self-locking regulators equal to Ventlok 644, Durodyne, or equal for rectangular ductwork, and Ventlok 637, Durodyne, or equal for round ducts.

C. Fire Dampers and Combination Fire/Smoke Dampers:

1. Fire dampers and combination fire/smoke dampers shall be listed and approved by the California State Fire Marshal. Installation shall conform to the manufacturer’s UL approved installation instructions.

a. Fire dampers shall be UL 555 classified and labeled as dynamic fire dampers approved for wall and floor installation. They shall ship from the manufacturer as an assembly with a minimum 20-gauge factory installed sleeve. Sleeve length shall suit the requirements of the wall construction. Each dynamic fire damper/sleeve assembly shall ship complete with factory “roll formed” one-piece angles with pre-punched holes for easy installation. Dynamic fire dampers for vertical installation must consist of a single section on sizes up to 33” x 36” and a single section on sizes up to 24” x 24” for horizontal installation. 1-1/2 hour dynamic fire dampers shall be Ruskin DIBD20, Pottorff, or equal. 3 hour dynamic fire dampers shall be Ruskin DIBD230, Pottorff, or equal.

b. Fire dampers for high pressure/velocity systems where velocities exceed 2000 fpm and/or 4” w.g. pressure fire damper shall be Ruskin FD60, Pottorff, or equal.

c. Fire dampers for ceiling installation shall be UL 555C classified and labeled as ceiling dampers. They shall be provided with a thermal insulating blanket to fit the inlet or outlet condition if required by the application. Ceiling dampers shall be Ruskin CFD 2, 3, 4 or 5.

Ceiling dampers for ceilings constructed of wood shall have UL tested in design L501 and shall be Ruskin CFD7, Pottorff, or equal.

d. Combination fire/smoke dampers. Dampers shall be UL classified and labeled as Leakage Class I Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall be warranted to be free from defects in material and workmanship for a period of 5 years after date of shipment. Damper/actuator assembly shall be tested to full open and full close at minimum 2000 fpm 250° F heated air and 4" w.g. with airflow in both directions. (Specified select: 250° / 350°, 2000 fpm/3000 fpm). Each damper shall be equipped with "controlled closure" quick detect heat actuated release device to prevent duct and HVAC component damage resulting from instantaneous damper closure. Release device shall be EFL type and shall allow reset from outside the sleeve after moderate temperature exposure. (Replacement type fusible links not acceptable.)

e. Two position combination fire smoke dampers shall be equipped with one or more factory installed, direct coupled, 120 volt, single phase, electric actuator for energize open – fail close operation. Dampers with multiple actuators shall be factory wired with single point connection at the EFL heat release device for connection to power. Damper actuator shall include minimum one-year energized hold open (no cycles) and spring return (fail) close reliability. Damper/actuator shall include minimum 20,000 full open-full close cycle performances.

f. Modulating combination fire smoke dampers shall be equipped with one or more factory installed contact for modulating signal connection. Damper/actuator shall include minimum 100,000 full open-full close cycle performances with spring return (fail) close on loss of power.

g. Round combination fire smoke dampers up to 24" diameter shall be true round type with minimum 20 gauge galvanized steel designed for lowest pressure drop and noise performance. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade seals shall be silicone edge designed to withstand 450° F and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Each damper shall be equipped with a factory-installed sleeve of 17 inches minimum length and factory "roll formed" one-piece angles with pre-punched holes. Dampers shall be Ruskin FSDR25, Pottorff, or equal.

h. Round (larger than 24" diameter) or rectangular combination fire smoke dampers shall include roll-formed structural hat channel frame, reinforced at the corners, formed from a single piece of minimum 16 gauge equivalent thickness formed from single piece galvanized steel. Bearings shall be stainless steel turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450° F and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Each damper shall be equipped with a factory-installed sleeve of 17" minimum length and factory "roll formed" one-piece angles with pre-punched holes for easy installation. Dampers shall be Ruskin FSD60, Pottorff, or equal.

i. 3-hour rated combination fire smoke dampers shall be Ruskin model FSD60-3, Pottorff, or equal.

j. All FSD60 type dampers shall be AMCA licensed and shall bear the AMCA Seal for Air Performance. AMCA certified testing shall verify pressure drop does not exceed .03" w.g. at a face velocity of 1,000 fpm on a 24" x 24" damper.

k. Wall type fire/smoke damper:

1) Combination fire/smoke dampers for use in the wall of exit corridors shall be classified and labeled as Leakage Class II Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall meet the requirements for combination fire/smoke

dampers in paragraph 3 above except AMCA certified testing shall verify pressure drop does not exceed .07" w.g. at a face velocity of 1,000 fpm on a 24" x 24" damper and blades shall be single skin galvanized steel 10 gauge minimum with 3 longitudinal grooves for reinforcement. Dampers shall be Ruskin FSD36, Pottorff, or equal.

2) Front access combination fire/smoke dampers shall meet all the requirements for combination fire/smoke dampers in paragraph 3 above except pressure drop requirement. In addition the dampers shall be constructed so that actuators and all accessories are accessible from the grille side. Actuators and accessories shall be housed within an integral cabinet on the side of the damper frame and shall not be installed in the air stream in front of the damper. The damper sleeve shall be minimum 14" and flanged to accept a steel framed grille. The sleeve shall be covered with fire resistant material. Dampers shall be Ruskin FSD60FA, Pottorff, or equal.

l. Ceiling type fire/smoke damper for tunnel type corridor construction: Combination fire/smoke dampers for use in the corridor ceiling of tunnel type corridor construction shall be UL classified and labeled as Corridor Damper. Dampers shall meet the requirements of paragraph 4a above except pressure drop testing does not require AMCA certification. Dampers shall be Ruskin FSD36C, Pottorff, or equal.

m. Fusible links shall have temperature rating approximately 50° F above normal maximum operating temperature of the heat producing appliance.

1) If project requires re-openable fire/smoke dampers, provide Ruskin 165 ° F / 350° F TS150, NCA or equal. The TS150 firestat replaces the EFL and allows the damper to be re-opened from remote location up to 350 ° F. TS150 shall include full open and full closed damper position contacts for interface with remote position indication panel.

2) Each fire/smoke damper shall be equipped with "controlled closure" quick detect heat actuated release device to prevent duct and HVAC component damage. Release device shall allow easy reset after moderate temperature rise outside the sleeve. Heat release device shall be the Ruskin EFL, NCA or equal.

3) Unless the system is using a validation control system, each fire/smoke damper shall be equipped with a control panel including blade position indicator lights and a key operated switch. The panel cover shall be oversized for flush mount into the wall or ceiling and shall have a brushed look. Control panel shall be Ruskin MCP2, Pottorff, or equal.

2. All actuators used for smoke dampers or combination fire/smoke dampers shall have a cycle time requirement of not more than every twelve months and shall be rated for continuous "0n" duty and shall be provided with internal spring return. Actuators shall be equipped with pilot light, remote key test switch, end switch and circuitry to activate pilot light on remote key (test) switch located in corridor ceiling adjacent to damper. Electric motors shall be Invensys MA-250, MA-253, Honeywell H2000, or equal.

D. Where required to suit the size of damper required, provide manufacturers standard UL Classified mullions, arranged to support multiple dampers. Assembly shall be of minimum 16 gauge galvanized steel, complete with all accessory caps and framing members required for installation.

2.26 DUCTWORK

A. Construct and install sheet metal ductwork in accordance with the California Mechanical Code for 2 inches static pressure for supply air, and 2 inches minimum for return and exhaust air unless otherwise noted on Drawings.

1. Where not in conflict with the California Mechanical Code, construct and install all sheet metal ductwork in accordance with SMACNA HVAC Duct Construction Standards (Metal and Flexible).

Where applicable for HVAC work, construct and install sheet metal work in accordance with SMACNA Architectural Sheet Metal Manual.

2. Provide variations in duct size, and additional duct fittings as required to clear obstructions and maintain clearances as approved by the Architect at no extra cost to the Owner.

3. Gauges, joints and bracing shall be in accordance with the California Mechanical Code.

4. Provide beading or cross breaking for all ductwork inside building. Provide cross breaking for ductwork exposed to weather.

5. At the contractor's option, ductwork may be fabricated using the Ductmate, Nexus, Quickduct, Transverse Duct Connection (TDC), Pyramid-Loc duct connection systems, or equal. Fabricate in strict conformance with manufacturer's written installation instructions and in accordance with California Mechanical Code.

   a. Seal flanged ends with pressure sensitive high density, closed cell neoprene or polyethylene tape gasket, Thermo 440, or equal.

   b. Provide metal clips for duct connections, except at breakaway connections for fire dampers and fire smoke dampers. Provide corner clips at each corner of duct, through bolted, at all locations except at breakaway connections for fire dampers and fire smoke dampers. Where used on locations exposed to weather, provide continuous metal clip at top and sides of duct, with 1 inch overhang for top side.

B. Design and installation standards:

1. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) for all work in this section.

2. NFPA Compliance: Comply with ANSI/NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," and ANSI/NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

3. California Mechanical Code.

C. Duct sizes indicated are external sizes.

D. Galvanized Sheet Steel: Lock-forming quality, ASTM A924 and ASTM A653, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

1. Provide mill certification for galvanized material at request of the Project Inspector.

E. Duct Sealants:

1. Sealant shall have a VOC content of 250 g/L or less.

2. Sealant shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

3. Provide one part, non-sag, synthetic latex sealant, formulated with a minimum of 68 percent solids. Sealant shall comply with ASTM E84, Surface Burning Characteristics.

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

      1) Design Polymerics, model DP1010.

      2) Polymer Adhesive Sealant Systems Inc, model Airseal #11.

3) McGill Airseal, LLC.

F. Duct Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, straps, trim, and angles for support of ductwork.

G. Rectangular Duct Fabrication:

1. Shop fabricate ductwork of gauges and reinforcement complying with the more stringent of the following standards, except as noted herein.

a. SMACNA HVAC Duct Construction Standards

b. California Mechanical Code

2. Fabricate ducts for 2 inch pressure class with minimum duct gauges and reinforcement as follows, except as otherwise noted:

Table A

Duct Dimension	Minimum Gauge	Joint Reinforcement Per CMC
Through 12"	26	Not Required
13" through 18"	24	Not Required
19" through 30"	24	C/4
31" through 42"	22	E/4
43" through 54"	22	F/2
55" through 60"	20	G/4
61" through 84"	20	I/2
85" through 96"	20	J/2
Over 96"	18	K/2

3. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Fabricate to include single thickness turning vane in elbows where space does not permit the above radius or where square elbows are shown. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers. Turning vanes shall be E-Z Rail II, Durodyne, or equal.

4. Fabricate round supply connections at rectangular, plenum type fittings using spin-in type fittings, complete with extractor and volume control damper. Refer to Paragraph “DAMPERS” for damper requirements.

5. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations. On ducts with flat seams, provide standard reinforcing on inside

of duct. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.

6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.

7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.

H. Rectangular Internally Insulated Duct Fabrication:

1. Provide internal duct lining where indicated on the Drawings, with a minimum of 10'-0" length in each direction from the fan, fan casing, or unit casing. Line all transfer ducts.

a. Where ductwork is exposed to weather or outside the building insulation envelope, provide 2 inch thick, 1-1/2 pound density internal lining with matte facing, with an R-Value of 8.0 minimum.

b. Where ductwork is within the building insulation envelope, lining shall be 1” thick, 1-1/2 pound density, with R-value of 4.2 minimum.

c. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.

d. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).

e. Cement duct liner in place with nonflammable, non-hardening duct adhesive. Seal all raw edges of insulation inside ductwork with adhesive, including longitudinal liner edges.

f. Provide metal nosing at all locations where liner is preceded by unlined metal.

g. Provide sheet metal weld pins and washers or clinch pins and washers on all ductwork on 12 inch intervals with the first row within 3 inches of the leading edge of each piece of insulation and within 4 inches of corners. No use of adhesive mounted pins will be considered.

1) Install clinched pin fasteners with properly adjusted automatic fastening equipment. Manual installation will not be considered.

2) Install weld pins with properly adjusted automatic fastening equipment. Installation shall not damage the galvanized coating on the outside of the duct.

h. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.

i. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

Manufacturer:	Product:
Johns Manville	Linacoustic RC
CertainTeed Corporation	ToughGard

Fosters Adhesive	85-62
Swifts Adhesive	7336

I. Round and Oval Ductwork Fabrication:

1. Round and oval duct and fittings shall be spiral lockseam or longitudinal seam as indicated in table below. Provide couplings to join each length of duct.

   a. At contractors' option, round or oval ductwork may be utilized in place of rectangular ductwork shown on Drawings, provided available space allows installation of round or oval ductwork without compromising space required for installation of products and systems of other trades.

      1) Round or oval ductwork utilized in place of rectangular ductwork shown on Drawings shall be sized to have a static pressure loss equivalent to rectangular duct shown on Drawings.

      2) Unlined round or oval duct shall not be utilized in place of rectangular internally lined ductwork shown on Drawings.

2. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Provide two-piece, die-stamped, 45-degree to 90-degree elbows for sizes up to 12 inches; five-piece, 90-degree elbows for sizes 12 inches and above; conical tees; and conical laterals. All reducers shall be placed after a tap has been made on the duct main. Reducers shall be long-taper style.

3. Round Ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 653 by the following methods and in minimum gauges listed.

Diameter	Minimum Gauge	Method of Manufacture
Up to 14"	26	Spiral Lockseam
15" to 23"	24	Spiral Lockseam
24" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam
51" to 60"	18	Spiral Lockseam
Over 60"	14	Longitudinal Seam

4. Provide locked seams for spiral duct; fusion welded butt seam for longitudinal seam duct.

5. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams at exposed ducts. Provide spot weld bonded seams at concealed ducts.

Diameter	Minimum Gauge
3" to 36"	20
38" to 50"	18
Over 50"	16

6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.

7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.

J. Round Internally Insulated Duct and Fittings: Where ductwork is exposed to weather or outside the building insulation envelope, construct with outer pressure shell, 2 inch thick (Minimum R-value = R-8) insulation layer, and perforated inner liner. Where ductwork is within the building insulation envelope, construct with outer pressure shell, 1 inch thick (minimum R-value = R4.2) insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ANSI/ASTM A 653, of spiral lockseam construction (use longitudinal seam for over 59 inches), in minimum gauges listed in table below. Where installed exposed in the conditioned space: duct and fitting outer pressure shell shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value = R-4.2), and perforated inner liner.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" TO 12"	26 gauge	24 gauge
13" TO 24"	24 gauge	24 gauge
25" to 34"	22 gauge	24 gauge
35" to 48"	20 gauge	24 gauge
49" to 58"	18 gauge	24 gauge
Over 59"	16 gauge	20 gauge

1. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell at exposed ducts. Provide spot weld bonded seams at concealed ducts.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 34"	20 gauge	24 gauge
36" to 48"	18 gauge	24 gauge
Over 48"	16 gauge	24 gauge

2. Inner Liner: Perforate with 3/32 inch holes for 22 percent open area. Provide metal spacers welded in position to maintain spacing and concentricity.

3. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.

4. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).

5. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.

6. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

   a. Sheet Metal Div., McGill AirFlow, LLC., Acousti-k27

   b. Semco Duct and Acoustical Products, Inc.

   c. Air Systems Manufacturing, Inc. - Las Vegas

K. Duct Access Doors:

1. Duct Access: Provide hinged access door in rectangular ducts for access to fire dampers, control equipment, etc. Access door size shall be duct diameter wide by duct diameter high for all ducts under 24 inches. Ducts over 24 inches in diameter shall have 24-inch by 18-inch access doors. Minimum size access doors shall be 6 inches by 6 inches.

2. Provide hinged style access doors for round ductwork, NCA Manufacturing, Inc., Model AD-RD-87, Pottorff Series 60, or equal. Access doors shall be 16 gauge galvanized steel with continuous piano hinge. Locks shall be plated steel strike and catch. Provide 1" x 3/8" Polyethylene "Perma Stik" gasket all around door.

L. Flexible Air Ducts:

1. Provide exterior reinforced laminated vapor barrier, fiberglass insulation, encapsulated spring steel wire Helix, and impervious, smooth, non-perforated interior vinyl liner. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars.

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

      1) C.A. Schroeder, Inc., Cal Flex model 2PMJ.

      2) ThermaFlex model M KC.

2. Factory made air ducts shall be approved for the use intended and shall conform to the requirements of UL 181 and NFPA 90A. Each portion of a factory-made air duct system shall be identified by the manufacturer with a label or other suitable identification indicating compliance with UL 181, Class 1. Ducts shall be UL listed Class 1, maximum 25/50 smoke and flame spread and shall be installed in accordance with the terms of their listing and the requirements of SMACNA HVAC Duct Construction Standards (Metal and Flexible). Factory-made air ducts shall have the following minimum R-values: R-6.0 for ductwork installed within the building insulation envelope, R-8.0 for ductwork installed outside the building insulation envelope.

3. Flexible ductwork shall be maximum of 5 feet long, and shall be extended to the fullest possible length, in order to minimize pressure drop in the duct.

4. Flexible ducts shall be selected for minimum of 6 inch positive static pressure and minimum of 1 inch negative static pressure.

M. Fabric Duct Air Dispersion System:

1. Duct: Fabric duct shall be constructed of inherently fire resistant polyester fabric complying with flame spread and smoke development index requirements of NFPA 90A when evaluated in accordance with UL 723 or other standard acceptable to authorities having jurisdiction. Treated or laminated fabric is not acceptable. Fabric shall be classified according to ICC AC167 and UL 2518. Fabric weight shall be minimum 6.75 oz./sq. yd. as tested per ASTM D3776. Duct shall be designed for inlet static pressure range of 0.25-3.0 in. wg. Fabric shall withstand without damage temperature range of 0-180 degrees F. Fabric air permeability shall be 0.5 CFM per sq. ft. when tested according to the requirements of ASTM D737.

    a. Linear vent shall consist of round, open orifices in duct fabric, sized and spaced per Drawings, or as recommended by the manufacturer.

    b. Duct color shall be selected by Architect from among manufacturers' available colors.

2. Duct Shape Retention System: Provide duct with shape retention system consisting of removable, round, 360 degree hoops, placed inside duct and spaced at 5 ft. o.c., or as recommended by fabric duct system manufacturer.

3. Duct Connections: Provide fabric duct system with hardware for duct inlet connection to metal duct. Inlet connection shall include zipper for removal or maintenance of duct. Duct sections and end caps shall be provided with zippers for connection, removal, and maintenance, number and location as normally provided by the manufacturer for the size and arrangement of duct as shown on Drawings.

4. Provide system with airflow, pressure control, and balancing devices as shown on Drawings and Drawing schedules.

5. Mounting: Provide fabric duct system with hardware for galvanized cable suspension system detailed on Drawings. Provide hanger attachment points on fabric duct, with locations compatible with duct suspension system detailed on Drawings.

6. Warranty: Provide with manufacturers' minimum 10 year warranty.

7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. DurkeeSox.

    b. DuctSox.

N. Kitchen Exhaust Ducts (Type 1):

1. Fabricate kitchen exhaust ducts and supports used for removal of smoke and grease-laden air from cooking equipment of 16 gauge minimum black steel where concealed and of 18 gauge minimum Type 304 stainless steel where exposed. At Contractor's option, 18 gauge minimum Type 304 stainless steel may be used where concealed. Finish exposed stainless steel with Number 4 finish. All ductwork shall be of welded construction in accordance with Section 510 of California Mechanical Code. For duct construction, comply with SMACNA "HVAC Duct Construction Standards" and ANSI/NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."

2. Kitchen Exhaust Duct Access Panels:

    a. Provide listed duct access panel assembly of the same material and gauge used for the duct. Duct access panels shall conform to the following:

1) Fasteners: Black steel or stainless steel to match material used for the duct. Panel fasteners shall not penetrate duct wall.

2) Gasket: Comply with NFPA 96, grease-tight, high temperature ceramic fiber, rated for minimum 1500 °F.

3) Minimum Pressure rating: 10 inches wg., positive or negative.

b. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Ductmate Industries, Inc.

2) 3M.

3) Flame Gard, Inc.

3. Field-Applied Grease Duct Enclosure:

a. Thermal Ceramics Firemaster FastWrap XL, or equal, field-applied grease duct enclosure listed in accordance with ASTM E 2336.

O. Kitchen Exhaust Ducts (Type 2):

1. Cooking Equipment Exhaust Ducts:

a. Fabricate kitchen exhaust ducts and supports used for removal of vapor, heat and odors from cooking equipment of 16 gauge minimum black steel where concealed and of 18 gauge minimum Type 304 stainless steel where exposed. At Contractor's option, 18 gauge minimum Type 304 stainless steel may be used where concealed. Finish exposed stainless steel with Number 4 finish. All ductwork shall be of welded construction in accordance with Section 510 of California Mechanical Code. For duct construction, comply with SMACNA "HVAC Duct Construction Standards" and ANSI/NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."

2. Dishwasher Exhaust Ducts:

a. Fabricate dishwasher exhaust ducts and supports used for steam removal from dishwasher of 18 gauge minimum 304 stainless steel. All ductwork shall be of welded construction in accordance with Section 510 of California Mechanical Code. For duct construction, comply with California Mechanical Code, SMACNA "HVAC Duct Construction Standards," and ANSI/NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."

3. Duct Access Panels:

a. Provide duct access panel assembly of the same material and gauge used for the duct. Duct access panels shall conform to the following:

1) Fasteners: Black steel or stainless steel to match material used for the duct. Panel fasteners shall not penetrate duct wall.

2) Gasket: Comply with NFPA 96, grease-tight, high temperature ceramic fiber, rated for minimum 1500 °F.

P. Type 1 Clothes Dryer Exhaust Ducts: Provide aluminum duct and fittings in wall and ceiling as indicated on Drawings.

Q. Type 2 Clothes Dryer Exhaust Ducts:

1. Fabricate ducts and supports of 18 gauge minimum, Type 304, stainless steel. All duct seams and joints shall be welded. Finish exposed stainless steel with Number 4 finish.

R. Shower exhaust ducts: Provide ducts and supports from stainless steel for a length of 20 feet from exhaust grille or register.

S. Fume Hood Exhaust Ducts:

1. Round Ductwork:

a. Provide 18 gauge 304 stainless steel duct with spiral lockseam and welded joints. Fittings shall be 304 stainless steel, solid welded.

2. Rectangular Duct:

a. Provide 18 gauge 304 stainless steel duct with Pittsburgh lockseam and welded joints. Fittings shall be 304 stainless steel, solid welded.

3. Duct Finish: Where exposed to view, Number 4 finish.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. McGill Airflow, Inc.

b. SEMCO LLC.

T. Flexible Connectors:

1. Materials: Flame-retardant or noncombustible fabrics. Coatings and adhesives shall comply with UL 181, Class 1, with flame spread index of 25 or less, and smoke-developed index of 50 or less.

2. Metal-Edged Connectors: Factory fabricated with a fabric strip 3 inches wide attached to two strips of 3-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

3. Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

a. Minimum Weight: 26 oz./sq. yd.

b. Tensile Strength: Minimum 475 lbf/inch in the warp and minimum 375 lbf/inch in the filling.

c. Service Temperature: Minus 50 to plus 200 deg F.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. Ductmate Industries, Inc., model Proflex.

b. Ventfabrics, Inc., model Ventlon.

2.27 HYDRONIC PIPING

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with California Mechanical Code. Where more than one type of material or product is indicated, selection from materials or products specified is Contractor's option.

B. Chilled Water, Heating Hot Water, and Condenser Water Piping:

1. Copper Tube and Fittings Aboveground:

a. Copper Tube and Fittings Aboveground: ASTM B88, Type L, drawn-temper, 150 psig minimum working pressure at 200 deg. F. Provide wrought-copper fittings and unions, ASTM B16.22, with full solder cup. Capped outlets shall be Schedule 40 screwed brass.

2. Steel Pipe and Fittings Aboveground:

a. 2 inches and smaller: ASTM A 53/A 53M, Schedule 40 black steel with plain ends, 150 psig minimum working pressure at 200 deg. F. Provide malleable-iron threaded fittings, ASTM B16.3, Class 150, and unions, ASTM B16.39, Class 150, and cast-iron flanges and flange fittings, and threaded joints.

b. 2-1/2 inches and larger: ASTM A 53/A 53M, Schedule 40 black steel with plain ends, 150 psig minimum working pressure at 200 deg. F. Provide wrought-steel fittings, ASTM A 234/A 234M, and wrought-cast or forged-steel flanges and flange fittings, ASME B16.5, material group 1.1, with butt welding end connections and raised face.

3. Underground Hydronic Piping:

a. Refer to Section 232113.13, Underground Hydronic Piping.

2.28 HYDRONIC PUMPS

A. Close-Coupled, End Suction Centrifugal Pumps

1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, cast iron, bronze-fitted, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

2. Pump Construction:

a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.

b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

c. Pump Shaft: Steel, with copper-alloy shaft sleeve.

d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

e. Pump Bearings: Permanently lubricated or grease lubricated ball bearings as normally furnished for pump size scheduled on Drawings.

3. Motor: Single speed and rigidly mounted to pump casing with integral pump support.

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1) Enclosure: Open, dripproof

2) Enclosure Materials: Rolled steel.

3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.

4) Efficiency: Premium efficient.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ITT Corporation; Bell & Gossett.

b. Armstrong Pumps Inc.

c. PACO Pumps.

d. TACO Incorporated.

B. Separately Coupled, Base-Mounted, End-Suction Centrifugal Pumps

1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, cast iron, bronze-fitted, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

2. Pump Construction:

a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.

b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

c. Pump Shaft: Steel, with copper-alloy shaft sleeve.

d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

e. Pump Bearings: Permanently lubricated or grease lubricated ball bearings as normally furnished for pump size scheduled on Drawings.

3. Shaft Coupling: Replaceable molded-rubber insert and interlocking spider capable of absorbing vibration. Provide EPDM coupling sleeve for variable-speed applications.

4. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

5. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

6. Motor: Single speed and secured to mounting frame, with adjustable alignment.

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1) Enclosure: Open, dripproof.

2) Enclosure Materials: Rolled steel.

3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.

4) Efficiency: Premium efficient.

7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ITT Corporation; Bell & Gossett.

b. Armstrong Pumps Inc.

c. PACO Pumps.

d. TACO Incorporated.

C. Close-Coupled, In-Line Centrifugal Pumps

1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, cast-iron, bronze fitted in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

2. Pump Construction:

a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.

b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

c. Pump Shaft: Steel, with copper-alloy shaft sleeve.

d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

e. Pump Bearings: Permanently lubricated or grease lubricated ball bearings as normally furnished for pump size scheduled on Drawings.

3. Motor: Single speed and rigidly mounted to pump casing.

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1) Enclosure: Open, dripproof.

2) Enclosure Materials: Rolled steel.

3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.

4) Efficiency: Premium efficient.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ITT Corporation; Bell & Gossett.

b. Armstrong Pumps Inc.

c. PACO Pumps.

d. TACO Incorporated.

D. Separately Coupled, Horizontally Mounted Centrifugal In-Line Pumps

1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, cast-iron, bronze fitted in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

2. Pump Construction:

a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.

b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

c. Pump Shaft: Steel, with copper-alloy shaft sleeve.

d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.

e. Pump Bearings: Permanently lubricated ball bearings.

3. Shaft Coupling: Replaceable molded-rubber insert with interlocking spider.

4. Motor: Single speed and resiliently mounted to pump casing.

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1) Enclosure: Open, dripproof.

2) Enclosure Materials: Rolled steel.

3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.

4) Efficiency: Premium efficient.

5. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ITT Corporation; Bell & Gossett.

b. Armstrong Pumps Inc.

c. PACO Pumps.

d. TACO Incorporated.

2.29 HYDRONIC PIPING SPECIALTIES

A. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. AMTROL, Inc.

    b. Armstrong Pumps, Inc.

    c. Bell & Gossett; a Xylem brand.

    d. TACO Comfort Solutions, Inc.

2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

B. Tangential-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. AMTROL, Inc.

    b. Armstrong Pumps, Inc.

    c. Bell & Gossett; a Xylem brand.

    d. TACO Comfort Solutions, Inc.

2. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.

3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.

4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.

5. Blowdown Connection: Threaded.

6. Size: Match system flow capacity.

C. Calibrated Balance Valves (Symbol CBV): Provide globe style valves for precision regulation and control rated 175 psi for sizes 2-1/2 inches through 12 inches and rated 240 psi for bronze sizes 2 inches and smaller. Each valve shall have two metering/test ports with internal check valves and protective caps. All valves shall be equipped with visual position readout and concealed memory stops for repeatable regulation and control.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

    a. Bell & Gossett Circuit Setter Plus.

    b. Armstrong CBV.

    c. Flow Design Inc. Accusetter.

d. Tour & Andersson.

e. Circuit Sensor with butterfly valve above 3 inches.

f. Illinois Series 5000 through 2 inches.

D. Pressure Independent Flow Limiting Balancing Valves:

1. Ball Valve Type:

a. Body: Dezincification resistant brass.

b. Cartridge: Removable, interchangeable, differential pressure regulating. Removable orifice plate to restrict maximum flow. Stainless steel spring. EPDM diaphragm.

c. Ball: Plated brass or stainless steel.

d. End Connections: Threaded or socket.

e. Temperature/Pressure Gage Test Ports: Integral seals for portable testing instruments.

f. Handle Style: Lever.

g. Blowdown port with field-installed drain valve with hose-end connection.

h. Provide valves with field-installed test port and operating handle extensions for insulated services.

i. CWP Rating: Minimum 400 psig.

j. Maximum Operating Temperature: 210 deg F.

2. Wafer Valve Type:

a. Body: Ductile Iron.

b. Cartridge: Single or multiple cartridges, removable, interchangeable, differential pressure regulating. Removable orifice plate to restrict maximum flow. Stainless steel spring. EPDM diaphragm.

c. End Connections: Flanged.

d. Temperature/Pressure Gage Test Ports: Integral seals for portable testing instruments. Provide valves with field-installed test port extensions for insulated services.

e. CWP Rating: Minimum 250 psig.

f. Maximum Operating Temperature: 230 deg F.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. Ball Valve Type:

1) Bell & Gossett; a Xylem Brand, model Circuit Sentry.

2) Griswold Controls, model Isolator “R”.

3) Caleffi North America, Inc, model Flocal.

b. Wafer Valve Type:

1) Bell & Gossett; a Xylem Brand, model Circuit Sentry Wafer Valve.

2) Griswold Controls, model Wafer AHU.

E. Air Vent Valves:

1. Provide Armstrong #1AV, Hoffman Model 78, Metraflex Model MV-15A, or equal, where automatic type air vent is shown.

2.30 THERMAL AND SEISMIC EXPANSION LOOPS

A. Manufactured assembly consisting of inlet and outlet elbow fittings, two sections of flexible metal hose and braid, and 180-degree return bend. Return bend section shall have support lug and plugged FPT drain. Flexible hose shall consist of corrugated metal inner hose and braided metal outer sheath. Assemblies shall be constructed from materials compatible with the fluid or gas being conveyed and shall be suitable for the system operating pressure and temperature. Provide assembly selected for 4 inches of movement.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Metraflex Inc., Metraloop series, or comparable product by one of the following, or equal:

1. Flexicraft Industries.

2.31 PIPE JOINING MATERIALS

A. Refer to Division 22 and 23 piping sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated

a. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.

2. AWWA C111, rubber, flat face, 1/8-inch (3.2mm) thick, unless otherwise indicated; and full-face or ring type, unless other indicated.

3. Flange Bolts and Nuts: AWWA C111, carbon steel, unless otherwise indicated.

C. Brazing Filler Metals:

1. General Duty: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.

2. Refrigerant Piping:

a. Joining copper to copper: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.

b. Joining copper to bronze or steel: AWS A5.8, Bag-1, silver alloy unless otherwise indicated.

D. Welding Filler Metals: Comply with ASME B31.1 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.32 VALVES

A. Gate Valves:

1. 2-1/2 inches and smaller: Class150, bronze body, union bonnet, rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Hammond IB641, IB648, Nibco T-134, S-134, Milwaukee 1151, 1169, or equal.

2. 3 inches and larger: Class 125, iron body, bronze mounted, bolted bonnet, non-rising stem, solid wedge, flanged ends, conforming to MSS SP-70. Hammond IR-1138, Nibco F619, Milwaukee F2882A, Stockham G-612, or equal.

3. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.

   a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.

   b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.

B. Ball Valves:

1. 2 inches and smaller: 600 psi CWP, 150 psi SWP, cast bronze body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T585-70, Milwaukee BA-400, Stockham T-285, or equal.

2. 2-1/2 inches and larger: Class 150, carbon steel body, full port, two piece, stainless steel vented ball, flanged ends, and reinforced PTFE seal, conforming to MSS SP-72. Nibco F-515-CS-F-66-FS, Milwaukee F20-CS-15-F-02-GO-VB, or equal.

C. Swing Check Valves: Class 125 or 150, bronze body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Stockham B-321, Milwaukee 509, or equal.

D. Butterfly Valves:

1. General: Tight closing, full lug type, with resilient seat suitable for minimum working pressure of 200 psig, conforming to MSS SP-67. Bi-direction dead end service with downstream flange removed.

2. Provide valves with the following:

   a. Seats: Suitable for 40 degrees F for cold water service and 250 degrees F for hot water service. Seats shall cover inside surface of body and extend over body ends.

   b. Bodies: Ductile iron or cast iron.

   c. Discs: Bronze or stainless steel.

   d. Stems or Shafts: Stainless steel.

   e. Control Handles: Suitable for locking in any position or with 10 degree or 15 degree notched throttling plates to hold valve in selected position. Provide extended necks to compensate for insulation thickness. Provide gear operator for valves 5 inches and larger.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

a. 2 through 12 inches: Milwaukee Valve, CL series, Nibco, Inc., model LD2000-3, or equal.

E. Silent Check Valves (for use on pump discharge):

1. General: Provide spring loaded check valves at pump discharge of all pumps.

a. 2 inches and smaller: 250 psi CWP, bronze body, Nibco Model T-480, Milwaukee 548-T, or equal.

b. 2-1/2 inches and larger: Class 250, cast iron body, wafer style, suitable for regrinding. Nibco Model F960, Milwaukee 1400, Mueller 103MAP, or equal.

2.33 VALVE BOXES

A. General:

1. Where several valves or other equipment are grouped together, provide larger boxes of rectangular “vault” type adequately sized for condition and similar in construction to those specified above.

2. Provide valve box extensions as required to set bottom of valve box tight up to top of piping in which valve is installed.

3. Provide a tee handle wrench for each size, Alhambra Foundry Co. #A-3008, or equal.

B. Valve Boxes in Traffic Areas: Provide Christy No. G5 traffic valve box, Brooks, or approved equal, 10-3/8 inches inside diameter with extensions to suit conditions, with cast iron locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves.

C. Valve Boxes in Non-Traffic Areas: Provide Christy No. F22, Brooks, or approved equal, 8 inches inside diameter by 30 inches long, with cast iron locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves. Cut bottom of plastic body for operation of valves.

D. Valve Box (Rectangular Vault Type): Precast concrete or cast iron with cast iron locking type covers lettered to suit service – Brooks No. 3-TL, Christy No. B3, Fraser No. 3, Alhambra A-3004 or A-3005, Alhambra E-2202, or E-2702, or approved equal, with extension to suit conditions.

2.34 INSULATION MATERIALS

A. General:

1. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2. Products shall not contain asbestos, lead, mercury, or mercury compounds.

3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

6. Test insulation, jackets and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723 or ASTM E84.

7. Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

B. Insulation Materials:

1. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1) Aeroflex USA, Inc.

2) Armacell LLC.

3) K-Flex USA.

2. Mineral-Fiber, Preformed Pipe Insulation:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1) Johns Manville; a Berkshire Hathaway company.

2) Knauf Insulation.

3) Manson Insulation Inc.

4) Owens Corning.

b. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL.

3. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Provide 2-inch wide stapling and taping flange.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1) CertainTeed Corporation.

2) Johns Manville.

3) Knauf Insulation.

4) Owens Corning.

4. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1) CertainTeed Corporation.

2) Johns Manville.

3) Knauf Insulation.

4) Owens Corning.

5. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

      1) CertainTeed Corporation.

      2) Johns Manville; a Berkshire Hathaway company.

      3) Knauf Insulation.

      4) Owens Corning.

C. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

      a. Design Polymerics.

      b. Foster Brand; H. B. Fuller Construction Products.

      c. Knauf Insulation.

   2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

   3. Service Temperature Range: 0 to plus 180 deg F.

   4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

      a. Design Polymerics.

      b. Childers Brand; H. B. Fuller Construction Products.

      c. Foster Brand; H. B. Fuller Construction Products.

   2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

   3. Service Temperature Range: Minus 50 to plus 220 deg F.

   4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

      a. Design Polymerics.

b. Childers Brand; H. B. Fuller Construction Products.

c. Foster Brand; H. B. Fuller Construction Products.

d. Knauf Insulation.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: 0 to plus 180 deg F.

4. Color: White.

F. Field Applied Jackets:

1. PVC Jacket and Factory Fabricated Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1) Johns Manville, model Zeston, with Zeston 2000 fitting covers.

2) Proto Corporation, model LoSmoke.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1) Childers Brand; H. B. Fuller Construction Products.

2) ITW Insulation Systems; Illinois Tool Works, Inc.

3) RPR Products, Inc.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.

d. Factory-Fabricated Fitting Covers:

1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

2) Tee covers.

3) Flange and union covers.

4) End caps.

5) Beveled collars.

6) Valve covers.

7) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.35 THERMAL HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. Buckaroos, Inc.
2. Carpenter & Paterson, Inc.
3. Clement Support Services.
4. Rilco Manufacturing Co., Inc.

B. Flame-spread index of 25 or less and smoke-developed index of 50 or less as tested by ASTM E 84.

C. Insulation-Insert Material for Cold or Hot Piping, from Minus 40 to Plus 275 Deg F: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength or ASTM C 1126, Type III rigid phenolic foam and vapor barrier.

1. Phenolic:

a. NPS 10 and Smaller: 3.75-lb/cu. Ft. minimum compressive strength.

b. NPS 12 to NPS 30: 5.0-lb/cu. ft. minimum compressive strength.

D. Insulation-Insert Material for Piping Above 275 Deg F: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

E. Insulation Protection Shields: Galvanized metal, G90 coating designation, complying with ASTM A 653/A 653M, 180-degree saddle.

F. Heavy Duty Insulation Protection Shields: Galvanized metal, 12-gage, G90 coating designation, complying with ASTM A 653/A 653M, 180-degree saddle. Structural steel plate welded to bottom of galvanized shield for sizes NPS 6 and larger.

G. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

H. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

I. Insert Length: Extend minimum 1-1/2 inches beyond sheet metal shield.

2.36 TEMPERATURE CONTROL SYSTEM

A. Refer to Section 23 09 23, Direct Digital Control System for HVAC.

PART 3 - EXECUTION

3.1 ROOF MOUNTED EQUIPMENT INSTALLATION

A. Mount and anchor equipment in strict compliance with Drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.

B. Examine rough-in for roof mounted equipment to verify actual locations of piping and duct connections prior to final equipment installation.

C. Verify that piping to be installed adjacent to roof mounted equipment allows service and maintenance.

D. Verify that gas piping will be installed with sufficient clearance for burner removal and service.

E. Install gas flue extensions. Attach gas flue extensions to unit according to unit manufacturers' installation instructions. Terminate gas flue extensions with lowest discharge opening at height compliant with requirements of California Mechanical Code, based on final unit location.

F. Install ducts to termination at top of roof curb and install heavy duty rubber gaskets on supply and return openings and on full perimeter of curb, or as required for an airtight installation, prior to setting unit on curb.

G. Cover roof inside each roof mounted air conditioning unit, heat pump unit, and heating and ventilating unit roof curb with 2 inch thick, 3 pound density fiberglass insulation board.

H. Connect supply and return air ducts to horizontal discharge roof mounted equipment with flexible duct connectors. Provide G 90 galvanized steel weather hood over flexible connections exposed to the weather. Weather hood minimum gauge shall be per PART 2 article, Ductwork, Table A.

I. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3.2 SPLIT SYSTEM AC, HEAT PUMP, AND VRF SYSTEMS INSTALLATION

A. General:

1. Install units level and plumb.

2. Install evaporator-fan components as detailed on Drawings.

3. Install ground or roof- mounted condensing units as detailed on Drawings.

4. Install seismic restraints as required by applicable codes. Refer to Article, Submittals, in Section 23 00 50, Basic HVAC Materials and Methods, for delegated design requirements for seismic restraints.

5. Install and connect refrigerant piping as detailed in unit manufacturers' literature. Install piping to allow access to unit.

6. Install cooling coil condensate primary drain pan piping, and overflow, if provided, and run to nearest code-compliant receptacle, or as indicated on Drawings. Install secondary drain pan for units installed over permanent and suspended-tile ceilings. Install secondary drain pan piping and terminate 1/2 inch below ceiling, with escutcheon, in a readily visible location or as shown on Drawings.

7. Install air filters at each indoor unit. Install washable, permanent filters at indoor units designed to accept washable, permanent filters. Refer to Drawings schedule, and Article, Air Filters, in this Section, for filter requirements for ducted, above-ceiling units incorporating mixing boxes.

8. Duct Connections: Duct installation requirements are specified in Article, Ductwork, in this Section. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Article, Ductwork, in this Section.

B. Variable Refrigerant Flow Split System Heat Pumps:

1. The system shall be installed by a factory-trained and certified contractor, in strict conformance with unit manufacturer's instructions.

2. Install indoor heat recovery controllers as detailed on Drawings. Install condensate drain pan piping and run to nearest code-compliant receptacle, or as indicated on Drawings.

a. Indoor Heat Recovery Controllers Identification:

1) Comply with requirements for identification in Section 23 00 50, Basic HVAC Materials and Methods.

2) Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3) Identify each refrigerant connection with label or tag corresponding to the indoor fan coil unit served by the refrigerant piping branch. Use equipment numbers scheduled on Drawings.

3. Install ball-type refrigerant service valves in refrigerant piping at downstream connections of indoor heat recovery units.

4. Install ground or roof- mounted condensing units as detailed on Drawings. Connected condensing units shall allow space for coil cleaning and other required maintenance tasks.

3.3 HIGH EFFICIENCY FURNACE UNIT INSTALLATION

A. Install vent and combustion air piping in strict compliance with manufacturer's installation guidelines. Pipe and fittings shall comply with manufacturer's instructions, flash through roof or wall as specified for piping. Refer to Drawings for special conditions.

1. Provide concentric flue system with single roof or wall penetration. Install in accordance with manufacturer's requirements.

2.

B. Mount horizontally or vertically as indicated on Drawings. Comply with manufacturer’s installation requirements specific to mounting orientation.

C. Install cooling coil overflow drain piping and run to nearest receptacle, or as indicated on Drawings.

3.4 REFRIGERANT PIPING INSTALLATION

A. General:

1. Install refrigerant piping according to ASHRAE 15. Install and connect refrigerant piping as detailed in unit manufacturers’ literature. Install piping to allow access to unit.

2. Install piping straight and free of kinks, restrictions or traps.

3. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

4. Slope horizontal suction piping 1 inch/10 feet towards compressor.

5. Install fittings for changes in direction and branch connections.

6. Piping under raised floors shall be kept 6 inches minimum above ground; excavate as necessary.

7. Install locking caps on refrigerant access valves located outside building, including valves located on roofs.

8. Insulate refrigerant piping, including liquid and hot gas pipes when required by system manufacturer, and including headers, branches, and other components as detailed in unit manufacturers’ literature.

B. Factory Pre-charged and sealed line set piping:

1. Keep the entire system clean and dry during installation.

2. All tubing shall be evacuated and sealed at the factory. The seal must not be broken until ready for assembly.

3. If there is any evidence of dust, moisture, or corrosion, the tubing must be cleaned out by drawing a swab soaked with methyl alcohol through the tubing as many times as necessary to thoroughly clean the tubing.

4. Where line set piping is used, enclose in iron or steel piping and fittings or in EMT conduit.

C. Field Assembled Refrigerant Piping:

1. Select system components with pressure rating equal to or greater than system operating pressure.

2. Where subject to mechanical injury, enclose refrigerant piping in EMT conduit.

3. Where field assembled refrigerant piping is exposed mounted at grade, on walls, and on roof, enclose in 16 gage galvanized steel enclosure.

4. When brazing, remove solenoid valve coils and sight glasses, also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

3.5 FAN INSTALLATION

A. Ceiling Mounted Fans: Mount variable speed switch within fan housing. Mark final balance point on variable speed switch.

B. Provide access doors for fans or motors mounted in ductwork.

C. Mount all fans as detailed on Drawings and in compliance with CBC standards.

D. Fan motors mounted in air-stream to be totally enclosed.

E. Completely line supply, return or exhaust fan cabinets with 1 inch thick, 3/4 pound density acoustic insulation securely cemented in place.

F. Roof fans shall be mounted level.

G. Provide heavy-duty rubber gasket between exhaust fan mounting flange and roof curb, or as required for an airtight installation.

H. Label fume hood fans with sign "CAUTION - HAZARDOUS EXHAUST."

3.6 RELIEF VENT INSTALLATION

A. Install relief vents to provide a level mounting for backdraft damper.

3.7 AIR INLETS AND OUTLETS INSTALLATION

A. Provide all air inlets and outlets with gaskets and install so that there will be no streaking of the walls or ceilings due to leakage. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.

B. Unless otherwise indicated on Drawings, provide rectangular galvanized steel plenum on top of each diffuser and ceiling return for connection to ductwork. Line plenum with internal insulation as indicated for lined ductwork. Size plenum to allow full opening into air terminal. Plenum sheet metal gauge shall be equal to gauge for rectangular equivalent of the branch duct serving the air inlet or outlet.

C. Ceiling-mounted air inlets, outlets, or other services installed in T-Bar type ceiling systems shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.

1. Air inlets, outlets, or other services weighing not more than 56 pounds shall have two No. 12 gauge hangers connected from the terminal or service to the structure above. These wires may be slack.

2. Support air inlets, outlets, or other services weighing more than 56 pounds directly from the structure above by approved hangers. Provide 4 taut 12 gauge wires each, attached to the fixture and to the structure above. The 4 taut 12 gauge wires, including their attachment to the structure above must be capable of supporting 4 times the weight of the unit.

3. Secure air inlets and outlets to main runners of ceiling suspension system with two No. 8 sheet metal screws at opposing corners.

D. Furnish all air inlets and outlets with a baked prime coat unless otherwise noted. Provide off-white baked enamel finish on ceiling-mounted air inlets and outlets. Paint exposed mounting screws to match the material being secured.

E. Air inlets and outlets shall match all qualities of these specified including appearance, throw, noise level, adjustability, etc.

3.8 AIR TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

D. Connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange, or as detailed on Drawings.

3.9 FILTER HOUSING INSTALLATION

A. Mount filters in airtight galvanized steel housings furnished by the filter manufacturer, or shop fabricated. Housings shall incorporate integral tracks to accommodate filters, and flanges for connection to duct or casing system.

1. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking latch handle devices.

B. Air filters shall be accessible for cleaning or replacement.

C. Identify each filter access door with 1/2 inch high minimum stenciled letters.

3.10 TEMPORARY FILTERS

A. Provide temporary filters for fans that are operated during construction; after construction dirt has been removed from the building install new filters at no additional cost to the Owner. In addition to temporary filters at filter location, provide temporary filters on all duct openings which will operate under a negative pressure.

1. Filters used for temporary operation shall be the same as permanent filters for the application. Filters used for duct openings may be 1 inch thick pleated media disposable type.

3.11 DAMPER INSTALLATION

A. All dampers automatically controlled by damper motors are specified under "Temperature Control System" except those specified with items of equipment.

B. Provide opposed blade manual air dampers at each branch duct connection and at locations indicated on the drawings and where necessary to control air flow for balancing system. Provide an opposed blade balancing damper in each zone supply duct. Provide an access panel or Ventlok flush type damper regulator on ceiling or wall for each concealed damper.

C. Install fusible link fire dampers full size of duct at points where shown or required.

D. Provide 18 inch x 12 inch minimum hinged access doors in ductwork and furring for easy access to each fire damper; insulated access doors in insulated ducts. Label access doors with 1/2 inch high red letters.

1. Provide Ventlok Series 100, Durodyne, or equal access doors with hardware for convenient access to all automatic dampers and other components of the system, insulated type in insulated ducts. Provide Ventlok #202 for light duty up to 2 inch thick doors, #260 heavy-duty up to 2 inch thick doors and #310 heavy-duty for greater than 2 inch thick doors. Provide #260 hinges on all hinged and personnel access doors; include gasketing.

3.12 DUCTWORK INSTALLATION

A. General:

1. Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight and noiseless (no objectionable noise) systems capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections within 1/8 inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type which will hold ducts true to shape and to prevent buckling. Where possible, install ductwork to clear construction by 1/4 inch minimum, except at air inlets and outlets. Where ductwork will not clear construction, secure duct firmly to eliminate noise in the system.

2. Duct Joints: Install duct sealers, pop rivets or sheet metal screws at each fitting and joint. Duct sealers shall be fire retardant. Sheet metal screws for joints shall be minimum #10 size galvanized.

3. Where ductwork is left exposed within a room, the same shall be run true to plumb, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.

4. Horizontal runs of ductwork suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from the Architect.

5. Provide sheet metal angle frame at all duct penetrations to wall, floor, roof, or ceiling.

6. Paint inside of ducts, visible through grille, dull black.

7. Where ductwork is installed in finished areas of buildings that do not have ceilings, paint ductwork, support hangers, and air inlets and outlets to match adjacent architectural surfaces, or as directed by Architect.

8. At the time of rough installation, or during storage on the construction site and until final startup of the heating and cooling equipment, duct and other related air distribution component openings shall be covered with tape, plastic, sheet metal, or other methods acceptable to the enforcing agency.

B. Firestopping:

1. Pack the annular space between duct openings and ducts penetrating floors and walls with UL listed fire stop, and sealed at the ends. All pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.

    a. Install fire caulking behind mechanical services installed within fire rated walls, to maintain continuous rating of wall construction.

2. Firestopping systems to be installed in strict accordance with manufacturer's instructions.

3. Alternate firestopping systems are acceptable if approved equal. However, any deviation from the above specification requires the Contractor to be responsible for determining the suitability of the proposed products and their intended use, and the Contractor shall assume all risks and liabilities whatsoever in connection therewith.

C. Flashing:

1. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.

2. Refer to Division 07 specifications and Drawings details as applicable.

3. Flashing for penetrations of roof for mechanical items such as flues and ducts shall be coordinated with the roofing manufacturer and roofing installer for the specific roofing type. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.

    a. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.

    b. Flues and ducts shall have 24 gauge galvanized sheet metal storm collar securely clamped to the flue above the flashing.

D. Upper connection of support to wood structure shall be with wood screws or lag screws in shear fastened in the upper one half of the wood structural member. Fasteners shall conform to the following schedule:

For ducts with P/2=30"	#10 x 1-1/2" wood screw
For ducts with P/2=72"	1/4"x 1-1/2" lag screw
For ducts with P/2 over 73"	3/8"x 1-1/2" lag screw

E. Upper connection in tension to wood shall not be used unless absolutely necessary. Where deemed necessary the contractor shall submit calculations to show the size fastener and penetration required to support loads in tension from wood in accordance with the following schedule:

For ducts with P/2=30"	260 pounds per hanger
For ducts with P/2=72"	320 pounds per hanger
For ducts with P/2=96"	460 pounds per hanger
For duct with P/2 larger than 120"	NOT ALLOWED

F. Install concrete inserts for support of ductwork in coordination with formwork as required to avoid delays in work.

G. Upper connection to manufactured truss construction must comply with truss manufacturers published requirements and Structural Engineers requirements.

H. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct plus insulation with sheet metal flanges of same gauge as duct. Overlap opening on four sides by at least 1-1/2 inches.

I. Support ductwork in manner complying with SMACNA "HVAC Duct Construction Standards," hangers and supports sections. Where special hanging of ductwork is detailed or shown on Drawings, Drawings shall be followed. Angles shall be attached to overhead construction in a manner so as to allow a minimum of 2 inches of movement in all directions with no bending or sagging of the angle.

1. Except where modified in individual paragraphs of this Section, provide hanger support with minimum 18 gauge straps, 1 inch wide. Fold duct strap over at bottom of duct.

2. Install duct supports to rectangular ducts with sheet metal screws. Provide one screw at top of duct and one screw into strap at bottom of duct.

J. Installation of Flexible Ductwork:

1. Provide flexible ducts with supports at 30 inch centers with 2 inch wide, 26 gauge steel hanger collar attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets.

a. Supports shall be in accordance with SMACNA HVAC Duct Construction Standards (Metal and Flexible).

b. Flexible duct bends shall be not less than 1-1/2 duct diameter bend radius.

2. Make connections to rigid duct and units with Panduit style draw band at inner liner material, and a second draw band over the outer vapor barrier material.

3. Make connection to duct with spin-in fittings, with air scoop and balance damper.

K. Installation of Fabric Duct Air Dispersion System:

1. Install fabric duct system in accordance with the requirements of the manufacturer, and per Drawings details.

a. Air handler and associated ductwork shall be clean and free of particulate matter at the time of fabric duct connection and pressurization of duct system.

2. Fabric duct shall be cleaned according to manufacturers' instructions, if soiled during installation, prior to Project handover to Owner.

L. Installation of Kitchen Exhaust Ducts (Type 1):

1. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease.

2. Slope duct a minimum of 2 percent to drain grease back to the hood.

3. Provide for thermal expansion of ductwork through 2000 ◦F temperature range.

4. Install listed grease duct access panel assemblies at each change of direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, and as indicated on Drawings. Locate access panel on top or sides of duct. Locate panel so that edge of opening is not less than 1-1/2 inch from all outside edges of the duct or welded seams. For large horizontal ducts, install 20 inch by 20 inch access panel for personnel entry at maximum intervals of 20 feet.

5. Install listed grease duct access panel assemblies in accordance with the terms of their listings and the manufacturers' instructions. Access panels shall be labeled with the words: "Access Panel – Do Not Obstruct."

6. Fabricate ducts with continuous welds for grease-tight construction.

7. Grind welds to provide smooth surface free of burrs, sharp edges and weld splatter. When welding stainless steel with a No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to removed discoloration caused by welding.

8. Cover grease exhaust duct with two layers of 1-1/2 inch thick field-applied grease duct enclosure. Install grease duct enclosure in accordance with manufacturer's instructions and listing requirements.

M. Installation of Kitchen Exhaust Ducts (Type 2):

1. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease.

2. Slope duct a minimum of 1 percent to drain back to the hood or dishwasher connection.

3. Install duct access panel assemblies at each change of direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, and as indicated on Drawings. Locate access panel on top or sides of duct. Locate panel so that edge of opening is not less than 1-1/2 inch from all outside edges of the duct. For large horizontal ducts, install 20 inch by 20 inch access panel for personnel entry at maximum intervals of 20 feet.

4. Fabricate ducts with continuous welds for water-tight construction.

5. Grind welds to provide smooth surface free of burrs, sharp edges and weld splatter. When welding stainless steel with a No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to removed discoloration caused by welding.

6. Fabricate ducts for dishwasher exhaust with seams on top of duct, and with minimum joints.

7. Access panels shall be labeled with the words: "Access Panel – Do Not Obstruct."

N. Installation of Shower Exhaust Ducts:

1. Slope duct a minimum of 1 percent to drain back to the exhaust grille.

3.13 DUCTWORK SEALING AND LEAK TESTING

A. All ductwork shall receive a Class A seal.

B. Seal airtight all joints and seams, including standing seams and manufactured joints and seams, of all supply, return and exhaust ducts except those exposed in conditioned space.

C. Leakage Classes:

Pressure Class	Leakage Class	
	Round Duct	Rectangular Duct
2"W.G. or less	8	16
4"W.G. or greater	2	4

D. All duct systems (supply, return, outside air intake, and exhaust), except those identified on compliance forms on Drawings as requiring Acceptance Testing per the requirements of the California Energy Code, shall be tested in accordance with the requirements of SMACNA “HVAC Air Duct Leakage Test Manual.” Test pressure shall be equal to the pressure class of the duct. For additional duct leak testing requirements, refer to Section 230800.13, “Title 24 Commissioning of HVAC.”

3.14 PIPING INSTALLATION

A. General:

1. All piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.

2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.

3. Install piping to permit application of insulation and to allow valve servicing.

4. Where piping or conduit is left exposed within a room, the same shall be run true to plumb, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.

5. Horizontal runs of pipes and conduits suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from the Architect.

6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.

7. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.

8. Verify final equipment and fixture locations for roughing-in.

9. Where piping is installed in walls within one inch of the face of stud, provide a 16 gauge sheet metal shield plate on the face of the stud. The shield plate shall extend a minimum of 1-1/2 inches beyond the outside diameter of the pipe.

10. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.

11. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.

12. Service Markers: Mark the location of each plugged or capped pipe with a 4 inch round by 30 inch long concrete marker, set flush with finish grade. Provide 2-1/2 inch diameter engraved brass plate as part of monument marker.

13. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.

B. Sleeves:

1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.

2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate the pipe from the concrete.

C. Floor, Wall, and Ceiling Plates:

1. Fit all pipes with or without insulation passing through walls, floors, or ceilings, and all hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.

D. Firestopping:

1. Pack the annular space between pipe sleeves and pipes penetrating floors and walls with UL listed fire stop, and sealed at the ends. All pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.

a. Install fire caulking behind mechanical services installed within fire rated walls, to maintain continuous rating of wall construction.

2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. All Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and in accordance with CBC requirements.

3. Sleeve penetrators shall have a built in anchor ring for waterproofing and anchoring into concrete pours or use the special fit cored hole penetrator for cored holes.

4. Copper and steel piping shall have SpecSeal, or equal, plugs on both sides of the penetrator to reduce noise and to provide waterproofing.

5. Firestopping systems to be installed in strict accordance with manufacturer's instructions.

6. Alternate firestopping systems are acceptable if approved equal. However, any deviation from the above specification requires the Contractor to be responsible for determining the suitability of the proposed products and their intended use, and the Contractor shall assume all risks and liabilities whatsoever in connection therewith.

E. Flashing:

1. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.

2. Refer to Division 07 specifications and Drawings details as applicable.

3. Flashing for penetrations of metal or membrane roof for pipes shall be coordinated with the roofing manufacturer and roofing installer for the specific roofing type.

a. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.

b. Furnish and install counterflashing above each flashing required. Provide Stoneman, or equal, vandalproof top and flashing combination. Elmdor/Stoneman Model 1540.

4. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.

3.15 PUMP INSTALLATION

A. Install pumps as shown on Drawings.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories. Manufacturer recommended clearances shall be maintained.

C. Independently support pumps and piping so that weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.16 HYDRONIC SPECIALTIES INSTALLATION

A. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

B. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

C. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers' recommendations, including requirements for straight pipe lengths at valve inlet and outlet.

D. Air Vent Valves:

1. Install with shutoff valves or cocks and drain to floor sink or drain.

2. At each high point of piping, and elsewhere where required for system air venting and drainage, provide manual air vent connection at top of pipe. Provide ball valve within 18 inches of ceiling in accessible location, and extend drain line to allow convenient access.

3.17 THERMAL AND SEISMIC EXPANSION LOOP INSTALLATION

A. Install expansion loops where piping crosses building expansion or seismic joints, between buildings, between buildings and canopies, and as indicated on Drawings.

B. Install expansion loops of sizes matching sizes of connected piping.

C. Install grooved-joint expansion joints to grooved-end steel piping.

D. Materials of construction and end fitting type shall be consistent with pipe material and type of gas or liquid conveyed by the piping system in which expansion loop is installed.

3.18 PIPE JOINTS AND CONNECTIONS

A. General:

1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.

3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.

B. Threaded Pipe: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply thread compound to external pipe threads: Rectorseal No. 5, Permatex No. 1, or equal.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for type of water conveyed by pipe. Join flanges with gasket and bolts according to ASME B31.9.

D. Copper Pipe and Tubing: All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except pneumatic control piping, and hydronic piping having grooved-end fittings and couplings.

E. Welded Pipe:

1. Make up with oxyacetylene or electric arc process.

2. All welding shall conform to the American Standard Code for Power Piping ASME B-31.1. When requested by the Architect, furnish certification from an approved testing agency or National Certified Pipe Welding Bureau that the welders performing the work are qualified.

3. All line welds shall be of the single "V" butt type. Welds for flanges shall be of the fillet type.

4. Where the branch is two pipe sizes smaller than the main or smaller, Bonney Weldolets, Threadolets, Nibco, or equal, may be used in lieu of welding tees.

F. Flexible Connections:

1. Furnish and install Thermo Tech., Inc. F/J/R, Metraflex, or equal, flexible couplings with limiter bolts on piping connections to all equipment mounted on anti-vibration bases, except fan coil units under 2000 cfm, on each connection to each base mounted pump and where shown. Couplings shall be suitable for pressure and type of service.

2. Flexible connections in refrigerant lines; Flexonic, Anaconda or equal, metal hose, full size.

3. Anchor piping securely on the system side of each flexible connection.

3.19 VALVE INSTALLATION

A. General:

1. Valves shall be full line size unless indicated otherwise on Drawings.

2. Install horizontal valves with valve stem above horizontal, except butterfly valves.

3. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

4. Locate valves for easy access and provide separate support where necessary.

5. Install valves in position to allow full stem movement.

6. Install exposed polished or enameled connections with special care showing no tool marks or exposed threads.

7. Butterfly valves conforming to the paragraph “Butterfly Valves” may be used in lieu of gate or globe valves for locations above grade.

8. Ball valves conforming to the paragraph “Ball Valves” may be used in lieu of gate valves for locations above grade for services 2-1/2 inches and smaller.

9. Valves 2-1/2 inches and smaller (except ball valves) in nonferrous water piping systems may be solder joint type with bronze body and trim.

10. Provide gate or globe valves on inlet and outlet of each pump.

B. Gate Valves:

1. Furnish valves in copper lines with adapters to suit valve / line requirements.

2. Underground gate valves:

   a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.

   b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.

C. Swing Check Valves: Install in horizontal position with hinge pin level.

D. Butterfly Valves: Install with stems horizontal.

E. Silent Check Valves: Install in horizontal or vertical position between flanges.

F. Valve Adjustment: Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.20 HANGER AND SUPPORT INSTALLATION

A. General: Support ductwork, equipment and piping so that it is firmly held in place by approved iron hangers and supports, and special hangers. Hanger and support components shall support weight of ductwork, equipment and pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, of same size as pipe or tubing on which used, or nearest available. Rigidly fasten hose faucets, fixture stops, compressed air outlets, and similar items to the building construction. The Architect shall approve hanger material before installation. Where building structural members do not match piping and ductwork support spacing, provide “bridging” support members firmly attached to building structural members in a fashion approved by the structural engineer.

   1. Materials, design, and type numbers for support of piping per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.

      a. Provide copper-plated or felt-lined hangers for use on uninsulated copper tubing.

   2. Materials and design for ductwork support shall be per SMACNA “HVAC Duct Construction Standards, Metal and Flexible.”

B. Hanger components shall be provided by one manufacturer: B-Line, Grinnell, Unistrut, Badger, or equal.

C. Riser clamps: B-line model B3373, or equal.

D. Rubber Neoprene Pipe Isolators:

   1. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls. Refer to Architectural Drawings for location of acoustical walls.

   2. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. The rubber shall have between a 45 to 55 durometer rating and a minimum thickness of 1/2 inch.

   3. Manufacturers:

      a. Vertical runs: Acousto-Plumb or equal.

      b. Horizontal runs: B-Line, Vibraclamp; Acousto-Plumb or equal.

E. Pipe Hanger and Support Placement and Spacing:

1. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.

2. Vertical piping hanger and support spacing: Provide riser clamps for piping, above each floor, in contact with the floor. Provide support at joints, branches, and horizontal offsets. Provide additional support for vertical piping, spaced at or within the following maximum limits:

Pipe Diameter	Steel Threaded or Welded (Note 3)	Copper Brazed or Soldered (Notes 3, 4)	CPVC & PVC (Note 2)
1/2 - 1”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
1-1/4 - 2”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
2-1/2 - 3”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
Over 4”	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)

a. Note 1: Provide mid-story guides.

b. Note 2: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.

c. Note 3: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.

d. Note 4: Includes refrigerant piping, including vapor and hot gas pipes.

3. Horizontal piping, hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced at or within following maximum limits:

Pipe Diameter	Steel Threaded or Welded (Note 2)	Copper Brazed or Soldered (Notes 2, 3)	CPVC & PVC (Note 1)
1/2 - 1"	6 ft.	5 ft.	3 ft.
1-1/4 - 2"	7 ft.	6 ft.	4 ft.
2-1/2 - 3"	10 ft.	10 ft.	4 ft.
Over 4"	10 ft.	10 ft.	4 ft.

a. Note 1: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.

b. Note 2: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.

c. Note 3: Includes refrigerant piping, including vapor and hot gas pipes.

4. Suspended Piping:

a. Individually suspended piping: B-Line B3690 J-Hanger or B3100 Clevis, complete with threaded rod, or equal. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support.

Pipe Size	Rod Size Diameter
2" and Smaller	3/8"
2-1/2" to 3-1/2"	1/2"
4" to 5"	5/8"
6"	3/4"

b. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

c. Trapeze Suspension: B-Line, or equal, 1-5/8 inch width channel in accordance with manufacturers' published load ratings. No deflection to exceed 1/180 of a span.

d. Trapeze Supporting Rods: Shall have a safety factor of five; securely anchor to building structure.

e. Pipe Clamps and Straps: B-Line B2000, B2400, or equal. Where used for seismic support systems, provide B-Line B2400 series, or equal, pipe straps.

f. Concrete Inserts: B-line B22-I continuous insert or B2500 spot insert. Do not use actuated fasteners for support of overhead piping unless approved by Architect.

g. Steel Connectors: Beam clamps with retainers.

5. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.

6. Insulated Piping:

a. Do not interrupt insulation at pipe hangers and clamps.

b. Use thermal hanger shield inserts or MSS protection saddles and shields.

c. Thermal Hanger Shield Inserts:

1) Use thermal-hanger shield insert with clamp sized to match OD of insert.

2) Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

3) For below ambient services, maintain continuous vapor barrier.

4) For Clevis or Band Hangers: Install thermal-hanger shield inserts with insulation protection shields.

5) For Trapeze or Clamped Systems: Install thermal-hanger shield inserts with heavy-duty insulation protection shields. Install additional 180-degree galvanized shield for top of support if clamping is required.

d. MSS Protection Saddles and Shields:

1) MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

2) MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

3) Shield Dimensions for Pipe: Of length recommended in writing by manufacturer to prevent crushing insulation. Not less than the following:

a) NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

b) NPS 4: 12 inches long and 0.06 inch thick.

c) NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

d) NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

e) NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

F. Piping Support to Structure:

1. Wood Structure: Provide and install wood blocking as required to suit structure. Provide lag screws or through bolts with length to suit requirements, and with size (diameter) to match the size of hanger rods required.

a. Do not install Lag screws in tension without written review and acceptance by Structural Engineer.

Side Beam Angle Clip	B-Line B3062--MSS Type 34
Side Beam Angle Clip	B-Line B3060
Ceiling Flange	B-Line B3199

b. Blocking for support of piping shall be not less than 2 inch thick for piping up to 2 inch size. Provide 3 inch blocking for piping up through 5 inch size, and 4 inch blocking for larger piping. Provide support for blocking in accordance with Structural Engineers requirements.

c. Where lag screws are used, length of screw shall be 1/2 inch less than the wood blocking. Pre-drill starter holes for each lag screw.

2. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the Architect.

G. Duct Hanger and Support Spacing: Conform to Requirements of CMC and SMACNA “HVAC Duct Construction Standards, Metal and Flexible.”

H. Duct Support to Structure:

1. Upper connection of support to wood structure shall be with wood screws or lag screws in shear fastened in the upper one half of the wood structural member. Fasteners shall conform to the following schedule:

For ducts with P/2=30"	#10 x 1-1/2" wood screw
For ducts with P/2=72"	1/4"x 1-1/2" lag screw
For ducts with P/2 over 73"	3/8"x 1-1/2" lag screw

2. Upper connection in tension to wood shall not be used unless absolutely necessary. Where deemed necessary the contractor shall submit calculations to show the size fastener and penetration required to support loads in tension from wood in accordance with the following schedule:

For ducts with P/2=30"	260 pounds per hanger
For ducts with P/2=72"	320 pounds per hanger
For ducts with P/2=96"	460 pounds per hanger
For duct with P/2 larger than 120"	NOT ALLOWED

3. Install concrete inserts for support of ductwork in coordination with formwork as required to avoid delays in work.

4. Upper connection to manufactured truss construction must comply with truss manufacturers published requirements and Structural Engineers requirements.

3.21 INSULATION AND FIELD-APPLIED JACKET INSTALLATION

A. General:

1. The term "piping" used herein includes pipe, air separators, valves, strainers and fittings.

2. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.

3. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, ductwork, and equipment.

4. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

5. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

6. Install insulation with longitudinal seams at top and bottom of horizontal runs.

7. Install multiple layers of insulation with longitudinal and end seams staggered.

8. Keep insulation materials dry during application and finishing.

9. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

10. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

11. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

12. For piping, ductwork, and equipment, with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

13. Repair all damage to existing pipe, duct and equipment insulation whether or not caused during the work of this contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.

14. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

    a. Install insulation continuously through hangers and around anchor attachments.

    b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

    c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

    d. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

B. Piping Insulation Installation:

1. General:

    a. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible.

    b. Provide removable insulation covers for items requiring periodic service or inspection.

    c. Insulation shall be vapor tight before applying PVC jacket and fitting covers. Verify suitability with manufacturer of insulation.

    d. Provide pre-formed PVC valve and fitting covers for indoor piping.

    e. Provide factory-fabricated aluminum valve and fitting covers for outdoor piping.

    f. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.

2. Below-Ambient Services Including Chilled Water Supply and Return and Refrigerant Piping:

    a. Insulate valves and irregular surfaces to match adjacent insulation and cover with two layers of woven glass fiber cloth saturated in Foster Sealfas 30-36, 3M, or equal, extending 3 inches over the adjoining pipe insulation. Finish with a coat of Foster Sealfas 30-36, 3M, or equal. The 3 inch wide SSL end laps furnished with the insulation shall be adhered over the end joints. Seal entire surface of insulation vapor tight, including joints and ends of PVC or aluminum fitting covers.

b. Variable refrigerant flow (VRF) heat pump systems: Insulation for VRF system refrigerant piping shall be installed according to VRF unit manufacturer's instructions.

3. PVC Jacket Installation:

a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

4. Aluminum Jacket Installation:

a. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch stainless-steel bands on 12 inch centers. Install jacketing with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Cover fittings with glass cloth, two coats of Foster Sealfas 30-36, and factory-fabricated aluminum fitting covers, of same material, finish, and thickness as jacket. Insulation shall be vapor tight before applying metal jacket and fitting covers.

b. Do not install aluminum jackets on refrigerant flexible connectors to vibration isolated outdoor condensing units. Coat elastomeric insulation with insulation manufacturer's recommended ultraviolet light protective coating.

C. Duct Insulation Installation:

1. General:

a. Insulation applied to the exterior surface of ducts located in buildings shall have a flame spread of not more than 25 and a smoke-developed rating of not more than 50 when tested as a composite installation including insulation, facing materials, tapes and adhesives as normally applied. Material exposed within ducts or plenum shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50.

b. Duct insulation applied to the exterior surface of ducts installed outside the building insulation envelope shall meet minimum R-value of R-8 at 3 inches thickness and 3/4 pound per cubic foot density.

c. Duct insulation applied to the exterior surface of ducts installed within the building insulation envelope shall meet minimum R-value of R-4.2 at 1-1/2 inches thickness and 3/4 pound per cubic foot density.

2. Mineral Fiber Blanket Installation:

a. Insulate all unlined concealed supply and return ducts with fiberglass duct wrap, manufactured as a blanket of glass fibers factory laminated to a reinforced foil/kraft vapor retarding facing. Provide 2 inch stapling and taping flange. Wrap insulation entirely around duct and secure with outward clinching staples on 6 inch centers. Provide mechanical fasteners at maximum 18 inch centers for all bottoms of duct which are greater than 24 inches. Lap all insulation joints 3" minimum. Insulate ducts installed tight against other work before hanging in place. Seal all seams, both longitudinal and transverse, and all staple and mechanical fastener penetrations of facing with scrim backed foil tape or recommended sealant, to provide a vapor tight installation.

3. PVC Jacket Installation:

a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Equipment Insulation Installation:

1. General:

a. Insulate pumps, coil u-bends where exposed outside airstream, air separators, heating hot water and chilled water storage tanks, and other elements that are in series with the fluid flow, according to the requirements of the California Energy Code.

2. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, and for percent coverage of tank and vessel surfaces.

b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

c. Protect exposed corners with secured corner angles.

d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

1) Do not weld anchor pins to ASME-labeled pressure vessels.

2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

3) On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.

4) Do not overcompress insulation during installation.

5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

6) Impale insulation over anchor pins and attach speed washers.

7) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment

or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

g. Stagger joints between insulation layers at least 3 inches.

h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

b. Seal longitudinal seams and end joints.

4. Insulation Installation on Pumps:

a. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism. Do not enclose or insulate pump motor.

b. Fabricate boxes from G90 galvanized steel, at least 0.050 inch thick.

c. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

5. PVC Jacket Installation:

a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

6. Aluminum Jacket Installation:

a. Where aluminum jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.22 TEMPERATURE CONTROL SYSTEM INSTALLATION

A. Provide thermostats where indicated on drawings. All wiring shall be in conduit. Provide all relays, transformers and the like to render the control system complete and fully operable. All control conduit to be rigid steel type.

3.23 EQUIPMENT START-UP

A. Initial start-up of the systems and pumps shall be under the direct supervision of the Contractor.

B. Equipment start-up shall not be performed until the piping systems have been flushed and treated and the initial water flow balance has been completed.

C. It shall be the responsibility of the Contractor to assemble and supervise a start-up team consisting of controls contractor, start-up technician, and test and balance contractor; all to work in concert to assure that the systems are started, balanced, and operate in accordance with the design.

D. After start-up is complete, instruct the Owner's personnel in the operation and maintenance of the systems. Obtain from the Owner's representative a signed memo certifying that instruction has been received.

E. For additional requirements, refer to article, Check, Test and Start Requirements, in Section 23 00 50, Basic HVAC Materials and Methods.

3.24 TESTING AND BALANCING

A. For testing and balancing requirements, refer to Section 23 05 93, Testing and Balancing for HVAC.

3.25 CLEANING AND PROTECTION

A. As each duct section is installed, clean interior of ductwork of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or where ductwork is to be painted.

B. Strip protective paper from stainless steel ductwork surfaces, and repair finish wherever it has been damaged.

C. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until connections are to be completed.

D. As each internally lined duct section is installed, check internal lining for small cuts, tears, or abrasions. Repair all damage with fire retardant adhesive.

3.26 EQUIPMENT MOUNTING

A. Mount and anchor equipment in strict compliance with Drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.

3.27 INDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping, Cooling-Only Systems:

1. Suction and hot-gas piping smaller than 1-1/2 inches diameter:

a. Flexible Elastomeric: 1/2 inch thick.

b. Mineral-Fiber, Preformed Pipe: 1/2 inch thick.

2. Suction piping 1-1/2 inches diameter and larger:

a. Flexible Elastomeric: 1 inch thick.

b. Mineral-Fiber, Preformed Pipe: 1 inch thick.

B. Refrigerant Vapor and Liquid Piping, Heat Pump Systems:

1. Vapor piping for heat pump applications smaller than 1-1/2 inches diameter:
    a. Flexible Elastomeric: 1-1/2 inches thick.
    b. Mineral-Fiber, Preformed Pipe: 1-1/2 inches thick.
2. Vapor piping for heat pump applications 1-1/2 inches diameter and larger:
    a. Flexible Elastomeric: 2 inches thick.
    b. Mineral-Fiber, Preformed Pipe: 2 inches thick.
3. Liquid piping for heat pump applications smaller than 1 inch diameter:
    a. Flexible Elastomeric: 1 inch thick.
    b. Mineral-Fiber, Preformed Pipe: 1 inch thick.
4. Liquid piping for heat pump applications 1 inch diameter and larger:
    a. Flexible Elastomeric: 1-1/2 inch thick.
    b. Mineral-Fiber, Preformed Pipe: 1-1/2 inch thick.

C. Hydronic Piping:

1. Chilled Water Piping:
    a. Piping smaller than 1-1/2 inches diameter:
        1) Mineral-Fiber, Preformed Pipe: 1/2 inch thick.
    b. Piping 1-1/2 inches diameter and larger:
        1) Mineral-Fiber, Preformed Pipe: 1 inch thick.
2. Heating Hot Water Piping:
    a. Piping smaller than 1-1/2 inches diameter:
        1) Mineral-Fiber, Preformed Pipe: 1-1/2 inch thick.
    b. Piping 1-1/2 inches diameter and larger:
        1) Mineral-Fiber, Preformed Pipe: 2 inches thick.

3.28 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping, Cooling-Only Systems:

1. All Pipe Sizes: Insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch thick.
    b. Mineral-Fiber, Preformed Pipe: 1 inch thick.

B. Refrigerant Vapor and Liquid Piping, Heat Pump Systems:

1. Vapor piping for heat pump applications smaller than 1-1/2 inches diameter:

a. Flexible Elastomeric: 1-1/2 inches thick.

b. Mineral-Fiber, Preformed Pipe: 1-1/2 inches thick.

2. Vapor piping for heat pump applications 1-1/2 inches diameter and larger:

a. Flexible Elastomeric: 2 inches thick.

b. Mineral-Fiber, Preformed Pipe: 2 inches thick.

3. Liquid piping for heat pump applications smaller than 1 inch diameter:

a. Flexible Elastomeric: 1 inch thick.

b. Mineral-Fiber, Preformed Pipe: 1 inch thick.

4. Liquid piping for heat pump applications 1 inch diameter and larger:

a. Flexible Elastomeric: 1-1/2 inch thick.

b. Mineral-Fiber, Preformed Pipe: 1-1/2 inch thick.

C. Refrigerant Flexible Connectors:

1. Flexible Elastomeric: Thicknesses as specified for rigid piping.

D. Chilled Water:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

E. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.29 INDOOR FIELD-APPLIED PIPING JACKET SCHEDULE

A. Piping, concealed: None.

B. Piping, exposed: PVC, 20 mils thick.

3.30 OUTDOOR FIELD-APPLIED PIPING JACKET SCHEDULE

A. All Piping: Aluminum, Stucco Embossed: Thickness as follows:

Outer Insulation Diameter (Inches)	Minimum Aluminum Jacket Thickness (Inch)	
	Rigid Insulation	Non-Rigid Insulation (1)
8 and Smaller	0.024	0.024
Larger Than 8 Thru 11	0.024	0.024
Larger Than 11 Thru 24	0.024	0.024
Larger Than 24 Thru 36	0.024	0.032
Larger Than 36	0.024	0.040

1. (1) Non-rigid Insulation is defined as having a compressive strength of less than 15 psi.

3.31 INDOOR DUCT INSULATION SCHEDULE

A. Ducts Located Within Building Thermal Envelope:

1. Minimum R-Value = R-4.2.

2. Supply and Return Ducts: Mineral Fiber Blanket, 1-1/2 inches thick, 0.75 lb/cu. ft.

B. Ducts Located Within Building Outside Thermal Envelope:

1. Minimum R-Value – R-8.0.

2. Supply and Return Ducts: Mineral Fiber Blanket, 3 inches thick, 0.75 lb/cu. ft.

3.32 OUTDOOR DUCT INSULATION SCHDULE.

A. Minimum R-Value = R-8.

B. Refer to article, Ductwork, for internal duct lining. Provide 2 inches thick internal duct lining where indicated on Drawings.

3.33 INDOOR FIELD-APPLIED DUCT JACKET SCHEDULE

A. Insulated ducts in concealed spaces: None.

B. Insulated ducts in exposed unconditioned spaces: PVC, 20 mils thick.

3.34 EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor and outdoor equipment that is not factory insulated.

B. Chilled-water pump insulation shall be the following:

1. Mineral-Fiber Board: Thickness equal to insulation thickness for connected pipes and 3-lb/cu. ft. nominal density.

C. Heating-hot-water pump insulation shall be the following:

1. Mineral-Fiber Board: Thickness equal to insulation thickness for connected pipes and 3-lb/cu. ft. nominal density.

D. Chilled-water expansion/compression tank insulation shall be one of the following:

1. Flexible Elastomeric: Thickness equal to insulation thickness for connected pipes.

2. Mineral-Fiber Board: Thickness equal to insulation thickness for connected pipes and 3-lb/cu. ft. nominal density.

3. Mineral-Fiber Pipe and Tank: Thickness equal to insulation thickness for connected pipes.

E. Heating-hot-water expansion/compression tank insulation shall be one of the following:

1. Mineral-Fiber Board: Thickness equal to insulation thickness for connected pipes and 3-lb/cu. ft. nominal density.

2. Mineral-Fiber Pipe and Tank: Thickness equal to insulation thickness for connected pipes.

F. Chilled-water air-separator insulation shall be one of the following:

1. Flexible Elastomeric: Thickness equal to insulation thickness for connected pipes.

2. Mineral-Fiber Board: Thickness equal to insulation thickness for connected pipes and 3-lb/cu. ft. nominal density.

3. Mineral-Fiber Pipe and Tank: Thickness equal to insulation thickness for connected pipes.

G. Heating-hot-water air-separator insulation shall be one of the following:

1. Mineral-Fiber Board: Thickness equal to insulation thickness for connected pipes and 3-lb/cu. ft. nominal density.

2. Mineral-Fiber Pipe and Tank: Thickness equal to insulation thickness for connected pipes.

3.35 INDOOR, FIELD-APPLIED EQUIPMENT JACKET SCHEDULE

A. Equipment, Concealed: None.

B. Equipment, Exposed: PVC: 20 mils thick.

3.36 OUTDOOR, FIELD-APPLIED EQUIPMENT JACKET SCHEDULE

A. All Equipment: Aluminum, Stucco Embossed. Thickness as follows:

Outer Insulation Diameter (Inches)	Minimum Aluminum Jacket Thickness (Inch)	
	Rigid Insulation	Non-Rigid Insulation (1)
8 and Smaller	0.024	0.024
Larger Than 8 Thru 11	0.024	0.024
Larger Than 11 Thru 24	0.024	0.024
Larger Than 24 Thru 36	0.024	0.032
Larger Than 36	0.024	0.040

1. (1) Non-rigid Insulation is defined as having a compressive strength of less than 15 psi.

[END OF SECTION 23 80 00]

SECTION 26 00 10

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Table of Contents, Division 26 - Electrical:

SECTION NO.	SECTION TITLE
260010	BASIC ELECTRICAL REQUIREMENTS
260060	POWER SYSTEM STUDY
260090	ELECTRICAL DEMOLITION
260513	MEDIUM-VOLTAGE CABLES
260519	BUILDING WIRE AND CABLE
260526	GROUNDING AND BONDING
260529	ELECTRICAL HANGERS AND SUPPORTS
260531	CONDUIT
260533	BOXES
260536	CABLE TRAYS
260539	UNDERFLOOR DUCTS
260543	UNDERGROUND DUCTS AND STRUCTURES
260553	ELECTRICAL IDENTIFICATION
260800	ELECTRICAL COMMISSIONING
260926	RELAY PANEL LIGHTING CONTROL
260942	DIGITAL LIGHTING CONTROL
260943	NETWORK ADDRESSABLE LIGHTING CONTROL
261013	AERIAL POWER DISTRIBUTION
261113	PRIMARY UNIT SUBSTATION
261116	SECONDARY UNIT SUBSTATIONS
261219	PAD-MOUNTED TRANSFORMERS
261223	SUBSURFACE-MOUNTED TRANSFORMERS
261313	PRIMARY SERVICE SWITCHGEAR
261316	LOAD INTERRUPTER SWITCHGEAR
261323	MEDIUM-VOLTAGE AUTOMATIC TRANSFER SWITCHES
262213	DRY TYPE TRANSFORMERS
262313	GENERATOR CONTROLS & PARALLELING SWITCHGEAR
262413	SWITCHBOARDS
262416	PANELBOARDS
262419	INTEGRATED DISTRIBUTION ASSEMBLIES
262423	SERVICE PEDESTALS
262500	BUSWAY
262513	TRACK BUSWAY SYSTEM
262600	POWER DISTRIBUTION UNIT
262716	CABINETS AND ENCLOSURES
262719	SURFACE RACEWAYS
262726	WIRING DEVICES

262736	ENERGY INFORMATION SYSTEMS
262816	OVERCURRENT PROTECTIVE DEVICES
262819	DISCONNECT SWITCHES
262900	MOTOR CONTROLS
263100	PHOTOVOLTAIC POWER SYSTEMS
263213	PACKAGED ENGINE GENERATOR SYSTEM
263323	CENTRAL BATTERY INVERTER SYSTEM
263350	STATIC UNINTERRUPTIBLE POWER SUPPLY
263353	STATIC UNINTERRUPTIBLE POWER SUPPLY
263356	MULTIPLE STATIC UNINTERRUPTIBLE POWER SUPPLY
263623	TRANSFER SWITCHES
263633	AUTOMATIC STATIC TRANSFER SWITCH
264113	LIGHTNING PROTECTION SYSTEM
264313	SURGE PROTECTIVE DEVICES
265000	LIGHTING
266113	FIRE ALARM SYSTEM
266213	FM200/PRE-ACTION FIRE SUPPRESSION INTERFACE
266226	TWO-WAY COMMUNICATION SYSTEM
266316	DISTRIBUTED ANTENNA SYSTEMS (DAS) FOR ERRCS

B. Work included: This Section includes general administrative and procedural requirements for Division 26. The following administrative and procedural requirements are included in this Section to supplement the requirements specified in Division 01.

1. Quality assurance.
2. Definition of terms.
3. Submittals.
4. Coordination.
5. Record documents.
6. Operation and maintenance manuals.
7. Project management and coordination services.
8. Contract modification pricing procedures.
9. Excavation.
10. Rough-in.
11. Electrical installation.
12. Cutting, patching, painting, and sealing.
13. Field quality control.
14. Cleaning.
15. Project closeout.
16. Interface/Responsibility Matrix.

C. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete and operable installation.

1. General and supplementary conditions: Drawings and general provisions of Contract and Division 01 of the Specifications, apply to all Division 26 Sections.
2. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, lighting pole foundations, etc. Refer to Division 31, Earthwork.
3. Selective demolition: Nondestructive removal of materials and equipment for reuse or salvage as indicated. Also dismantling electrical materials and equipment made obsolete by these installations. Refer to Division 02, Selective Demolition.
4. Concrete work: Include forming, steel bar reinforcing, cast-in- place concrete, finishing and grouting as required for underground conduit encasement, light pole foundations, pull box slabs, vaults, housekeeping pads, etc. Also includes setting of floor boxes in existing concrete slabs, saw-cutting of existing slabs and grouting of conduits in saw-cut. Refer to Division 03, Concrete.
5. Miscellaneous metal work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, luminaires, panelboards, distribution boards, switchboards, motor control centers, etc. Refer to Division 05, Miscellaneous Metals.
6. Miscellaneous lumber and framing work: Include wood grounds, nailers, blocking, fasteners and anchorage for support of electrical materials and equipment. Refer to Division 06, Rough Carpentry.
7. Moisture protection and smoke barrier penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight. Refer to Division 07, Thermal and Moisture Protection.
8. Access panels and doors: Required in walls, ceilings, and floors to provide access to electrical devices and equipment. Refer to Division 08, Access Doors also, Division 05, Metals.
9. Painting: Include surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, etc. where indicated as field painted in this Division. Refer to Division 09, Painting.
10. Luminaire supports: Provide slack support wire for luminaires installed in acoustical tile or lay-in suspended ceilings. Refer to Division 09, Acoustical Treatment.

D. Work furnished and installed under another Division requiring connections under this Division includes but is not limited to:

1. Electric motors.
2. Package mechanical equipment: fans, fan coil units, pumps, boilers, compressors, etc.

3. Flow switches and valve monitors for sprinkler system.
4. Elevator controllers.
5. Pre-wired electrified partition furniture.
6. Temperature control panel(s). (Line voltage only)
7. Irrigation controller(s). (Line voltage only)
8. FM-200 control panel. (Line voltage only)
9. Kitchen equipment and appliances.
10. Laboratory equipment.
11. Electric signage.
12. Electric door locks.
13. Electric heat trace tape.
14. Door hold-open/release devices.
15. Variable frequency drive units.
16. Chiller starters.
17. Motorized roll down/sliding doors and grills.
18. Motorized dock levelers.
19. Projection screens.

E. Items furnished under this Division, but installed and connected under another Division includes but is not limited to:

1. Diesel generator day tank. (Division 22)
2. Diesel generator silencer. (Division 23)
3. Generator daytank fuel strainer, manual fuel pump, check valve and any other specified accessories. (Division 22)
4. Remote radiator for generator. (Division 22)

F. Items furnished under another Division, but installed and connected under this Division includes but is not limited to:

1. Wall mounted control stations for motorized roll down and sliding doors.
2. Electric fire sprinkler water flow bells.
3. Speed control switches for ceiling exhaust fans.

1.02 QUALITY ASSURANCE

A. Reference to Codes, Standards, Specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.

B. When codes, standards, regulations, etc. allow Work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements, or extent of the Contract Documents. The Contract Documents address the minimum requirements for construction.

C. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:

1. California Electric Code (CEC).
2. California Building Code (CBC).
3. California Fire Code (CFC).
4. California Mechanical Code (CMC).

D. Standards: Equipment and materials specified under this Division shall conform to the following standards where applicable:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
CBM	Certified Ballast Manufacturers
ETL	Electrical Testing Laboratories
FS	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IPCEA	Insulated Power Cable Engineer Association
NEMA	National Electrical Manufacturer's Association
UL	Underwriters' Laboratories

E. Independent Testing Agency qualifications:

1. Testing Agency shall be an independent testing organization that will function as an unbiased authority, professionally independent of Manufacturer, Supplier and Contractor, furnishing and installing equipment or system evaluated by Testing Agency.
2. Testing Agency shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
3. Testing Agency shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories, Title 9, Part 1907.
4. On-site technical personnel shall be currently certified by the International Electrical Testing Association in electrical power distribution system testing.
5. Testing Agency shall use technicians who are regularly employed by the firm for testing services.
6. Contractor shall submit proof of above Testing Agency qualifications with bid documentation upon request.

F. All base material shall be ASTM and/or ANSI standards.

G. All electrical apparatus furnished under this Section shall conform to NEMA standards and the CEC and bear the UL label where such label is applicable.

H. Certify that each welder performing Work has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

1.03 DEFINITION OF TERMS

A. The following list of terms as used in the Division 26 documents shall be defined as follows:

1. "Provide": Shall mean furnish, install, and connect unless otherwise indicated.

2. "Furnish": Shall mean purchase and deliver to Project site.

3. "Install": Shall mean to physically install the items in-place.

4. "Connect": Shall mean make final electrical connections for a complete operating piece of equipment.

5. "As directed": Shall be as directed by the Owner or their authorized Representative.

6. "Utility Companies": Shall mean the company providing electrical, telephone or cable television services to the Project.

1.04 SUBMITTALS

A. Format: Furnish submittal data in electronic format for each Specification Section with a table of contents listing materials by Section and paragraph number.

B. Submittals shall consist of detailed Shop Drawings, Specifications, block wiring diagrams, "catalog cuts" and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication and material finish. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded. Furnish quantities of each submittal as noted in Division 01.

C. Each submittal shall be labeled with the Specification Section Number and shall be accompanied by a cover letter or shall bear a stamp stating that the submittal has been thoroughly reviewed by the Contractor and is in full compliance with the requirements of the Contract Documents or provide a Specification Section line-by-line compliance response statement with detailed exception/ deviation response statements for all applicable provisions for the applicable Specification Section. Any Specification Section lines without a detailed exception/ deviation response statement shall be treated as the Contractor or Vendor is submitting in full compliance with the applicable Specification Section requirements. Cover letters shall list in full the items and data submitted. Failure to comply with this requirement shall constitute grounds for rejection of data.

D. The Contractor shall submit detailed Drawings of all electrical equipment rooms and closets if the proposed installation layout differs from the construction documents. Physical size of electrical equipment indicated on the Drawings shall match those of the electrical equipment that is being submitted for review, i.e.: switchboards, panelboards, transformers, control panels, etc. Minimum scale: 1/4" = 1'- 0". Revised electrical equipment layouts must be approved prior to release of order for equipment and prior to installation.

E. As part of the equipment and fixture submittals, the Contractor shall provide anchorage calculations for floor and wall mounted electrical equipment and fixtures, distribution conduits and raceways, in conformance with the 2019 California Building Code (CBC) and ASCE 7-16. Use the Occupancy Category, Ground Accelerations, Site Class, Seismic Design Category, and Seismic Importance Factor as noted in the structural drawings. For components required for Life Safety or containing hazardous materials use Ip=1.5. Structural Calculations shall be prepared, stamped, and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.

F. The Manufacturer shall recommend the method of anchoring the equipment to the mounting surface and shall provide the Contractor with the assembly dimensions, weights, and approximate centers of gravity.

G. Review of submittals is for general conformance to design concept and general compliance with the Specification Sections. Submittal Review Comments do not imply waiver of Specifications Section requirements unless specifically noted.

H. All resubmittals shall include a cover letter that lists the action taken and revisions made to each Drawing and equipment data sheet in response to Submittal Review Comments. Resubmittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the resubmittal package.

I. Shop Drawings for the following systems must be prepared via a computer aided drafting (CAD)building information modeling (Revit) system for submission by the Contractor. The Engineer can provide CADRevit files of the electrical Contract Documents to the Contractor.

   1. Manufactured wiring system, Section 260519.
   2. Fire alarm system, Section 266113.
   3. Security system, Section 266513.
   4. Telecommunication cabling system, Section 267113.

J. Independent Testing Agency report:

   1. Testing Agency shall provide 3 copies of the complete testing report.
   2. Test report shall include the following:
      a. Summary of Project.
      b. Description of equipment.
      c. Equipment used to conduct the test.
         1) Type.
         2) Manufacturer.
         3) Model number.
         4) Serial number.
         5) Date of last calibration.
         6) Documentation of calibration leading to NIST standards.
      d. Description of test.

e. Test results, as compared to Manufacturers or industry accepted standards and tolerances.

f. Conclusion and recommendation.

g. Signature of responsible test organization authority.

3. Furnish completed test report to Engineer no later than 30-days after completion of testing, unless otherwise directed.

K. Substitutions:

1. All requests for substitutions shall conform to the general requirements and procedure outlined in Division 01.

2. Where items are noted as "or equal," a product of equal design, construction and performance will be considered. Contractor must submit to the Engineer all pertinent test data, catalog cuts and product information required substantiating that the product is in fact equal to that specified. Only one substitution will be considered for each product specified.

3. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility, and appearance. Materials, processes, or equipment, which in the opinion of the Engineer is equal in quality, utility, and appearance, will be approved as substitutions to that specified.

4. Whenever any material, process or equipment is specified in accordance with a Federal specification, an ASTM standard, an ANSI specification, UL rating or other association standard, the Contractor shall present an affidavit from the Manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, support test data to substantiate compliance shall be submitted by the Contractor at no additional cost.

5. Substitutions shall be equal, in the opinion of the Architect/Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Architect/Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted article or material to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work or from any provisions of the Specifications.

6. The Contractor shall be responsible for all expenses in connection with the substitution materials, processes, and equipment, including the effect of the substitution on the Contractor, Subcontractor’s, or other Contractor's Work. No substitution of material, processes or equipment shall be permitted without written authorization of the Architect/Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.

1.05 COORDINATION

A. Discrepancies:

1. In the event of discrepancies within the Contract Documents, the Engineer shall be so notified, within sufficient time, as delineated in Division 01, prior to the Bid Opening to allow the issuance of an Addendum.
2. If, in the event that time does not permit notification or clarification of discrepancies prior to the Bid Opening, the following shall apply: The Drawings govern in matters of quantity and the Specifications govern in matters of quality. In the event of conflict within the Drawings involving quantities or within the Specifications involving quantities or within the Specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Contractor's Bid. No additional allowances will be made because of errors, ambiguities or omissions that reasonably should have been discovered during the preparation of the Bid.

B. Project conditions:

1. Examination of Project site: The Contractor shall visit the Project site and thoroughly review the locale, working conditions, conflicting utilities, and the conditions in which the Electrical Work will take place. Verify all existing conditions in the field. No allowances will be made subsequently for any costs that may be incurred because of any error or omission due to failure to examine the Project site and to notify the Engineer of any discrepancies between Contract Documents and actual Project site conditions.
2. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover fixtures, equipment, devices, and apparatus and protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition any fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.
3. Supervision: Contractor shall personally or through an authorized and competent representative constantly supervise the Work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.

C. Preparation:

1. Drawings:
    a. Layout: General layout indicated on the Drawings shall be followed except where other Work may conflict with the Drawings.
    b. Accuracy: Drawings for the Work under this Section are essentially diagrammatic within the constraints of the symbology applied.

D. Utility company contacts:

1. Contact for electrical service:
2. Contact for telephone service:
3. Contact for television service:

1.06 RECORD DOCUMENTS

A. Provide Project Record Drawings as described herein:

1. Drawings shall fully represent installed conditions including actual locations of outlets, true panelboard connections following phase balancing routines, correct conduit, and wire sizing as well as routing, revised luminaire schedule listing Manufacturers and products installed and revised panel schedules. Contractor shall record all changes in the Work during the course of construction on blue or black line prints. These prints shall be made subject of monthly review by the Owner's Representative to ascertain that they are current. If not current, monthly payments may be withheld.
2. Record Drawings shall be the transfer of information on these prints to the construction documents via computer aided drafting (CAD)building information modeling (Revit) process. A set of Revit files of the electrical construction documents will be provided to the Contractor by the Engineer. For the BIM/clash detection process, a Revit file of the electrical construction documents will be provided to the Contractor by the Engineer, which will represent a LOD of 300 design level. The Contractor is responsible for updating the model with changes as well as taking the model to a LOD of 500 design level.
3. Record drawing submissions shall be provided to the Engineer to review upon the completion of the following phases of Work:
    a. All underground installation.
    b. Building electrical rough-in.
    c. Final electrical installation.
4. Include in the record drawing submission the following shop drawing submission with all updated installation information:
    a. Manufactured wiring system.
    b. Fire alarm system.
    c. Security system.
    d. Telecommunication cabling system
    e. Nurse call system.
    f. Intercom system.
    g. Television distribution system.
    h. School communication system.
    i. Public address system.
    j. Sound reinforcement system.
5. A single set of half size prints of the Record Drawings shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
    a. Two sets of full-size prints.
    b. Four sets of half-size prints.

c. One set of full size reproducibles.

d. Electronic files of Drawings in PDF and CADRevit.

B. Panel schedules:

1. Typewritten panel schedules shall be provided for panelboards indicating the loads served and the correct branch circuit number. Schedules shall be prepared on forms provided by the Manufacturer and inserted in the pocket of the inner door of each panelboard. See Section 262416: Panelboards for requirements.

2. A single set of the record panel schedules shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:

a. Fold and insert one copy of the appropriate schedule in the pocket of the inner door of each panelboard.

b. Three binders, each containing a full set of the panel schedules. Provide index listing all schedules and dividers for separation of schedules as follows:

1) 277/480V normal.

2) 277/480V emergency.

3) 277/480V legally required standby.

4) 277/480V optional standby.

5) 277/480V critical.

6) 277/480V life safety.

7) 277/480V equipment.

8) 277/480V generator equipment.

9) 120/208V normal.

10) 120/208V emergency.

11) 120/208V legally required standby.

12) 120/208V optional standby.

13) 120/208V critical.

14) 120/208V life safety.

15) 120/208V equipment.

16) 120/208V generator equipment.

C. Field labels, markings, and warning signs: Provide in accordance and as required by:

1. General: CEC Article 110.21.

2. High-Leg System: CEC Article 110.15.

3. Arc-Flash Warning: CEC Article 110.16.

4. Identification of Disconnecting Means: CEC Article 110.22 (A).

5. Engineered Series Combination Systems: CEC Article 110.22 (B).
6. Tested Series Combination Systems: CEC Article 110.22 (C).
7. Available Fault Current: CEC Article 110.24.
8. Depth of Working Space in Existing Buildings: CEC Article 110.26 (A)(1)(c).
9. Guarding of Live Parts: CEC Article 110.27 (C).
10. Locked Rooms or Enclosures: CEC Article 110.34 (C).
11. Manholes: CEC Article 110.75 (E).

1.07 OPERATION AND MAINTENANCE MANUALS

A. Prior to Project closeout furnish to the Owner, six (6) hard back 3-ring binders containing all bulletins, operation and maintenance instructions, part lists, service telephone numbers and other pertinent information as noted in each Section all equipment furnished under Division 26. Binders shall be indexed into Division Sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.

1.08 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. Overview: Contractor shall provide a Project Manager/Engineer for the duration of the Project to coordinate the Division 26 Work with all other trades. Coordination services, procedures and documentation responsibility shall include, but shall not be limited to the items listed in this Section.

B. Review of Shop Drawings prepared by other Subcontractors:

1. Obtain copies of all Shop Drawings for equipment provided by others that require electrical service connections or interface with Division 26 Work.
2. Perform a thorough review of the Shop Drawings to confirm compliance with the service requirements contained in the Division 26 Contract Documents. Document any discrepancy or deviation as follows:
    a. Prepare memo summarizing the discrepancy.
    b. Provide a copy of the specific shop drawing, indicating via cloud, the discrepancy.
3. Prepare and maintain a shop drawing review log indicating the following information:
    a. Shop drawing number and brief description of the system/material.
    b. Date of your review.
    c. Indication if follow-up coordination is required.

C. Request for information (RFI):

1. Thoroughly review the Contract Documents prior to the preparation and submission of an RFI. If an RFI is submitted, attach 8 1/2" x 11" copies of all relevant documents to clarify the issue.
2. Prepare and maintain an RFI log indicating the following information:
    a. RFI number and brief summary of the issue.

b. Date of issuance and receipt of response.

D. Clarification confirmation memo (CCM):

1. Either the Contractor will prepare CCM memos or the Engineer to confirm a decision clarifying the Contract Documents that does not impact cost or affect other trades.

2. Prepare and maintain a CCM log indicating the following information:

a. CCM number: Use CCM-C1, C2, etc. for memos issued by the Contractor and CCM-E1, E2, etc. for memos issued by the Engineer.

b. Brief summary of issue and date issued.

1.09 CONTRACT PRICING MODIFICATION PROCEDURES

A. Submission guidelines: This Section covers the criteria for direct costs, mark-ups, and documentation requirements to be followed by the Contractor for any pricing modification to the Base Contract, where unit pricing has not already been established.

1. Change orders: Pricing for additions or deletions to the Base Contract Scope of Work upon acceptance of bid value and receipt of authorization to proceed.

2. Allowances: Cost allowances may be assigned for specific Scope of Work outlined within the Base Contract where design has not been fully delineated on the Contract Documents. When detailed information is available, the Contractor shall prepare and submit a price quotation for the Work. This price quotation will be compared to the allowance value and any adjustments necessary to the Base Contract value shall be made via change order.

B. Direct costs:

1. Labor:

a. Hourly labor rates shall not exceed the prevailing wage for the County where the Work is being performed. The costs for all supervision, including general superintendents and foremen, shall be included in the mark-up defined herein. Working foremen will be considered a direct cost only if the individual is on the Project site physically installing Work under the change order.

b. Labor burden shall be based on rates currently in effect at the time the Work under the change order is being performed and shall include only fringe benefits by governing trade organizations, Federal Insurance Contribution Act, Federal and State Unemployment taxes, payroll taxes and net actual premium paid for public liability, workers' compensation, property damage and other forms of insurance required by the Owner. No other cost will be included aas labor burden.

c. NECA Manual of Labor Units will be utilized as the basis for determining labor productivity rates for Electrical Work as follows:

1) 85% of NECA column 1 (normal) for change in scope issued well in advance of Work needing to be performed, so as not to cause slow-down or Work stoppage.

2) 100% of NECA column 1 (normal) for Work being performed with other Base Contract Work, not out of sequence and with minimal slow-down or Work stoppage.

3) 100% of NECA column 2 (difficult) for Work performed out of sequence, requiring Work stoppage and reconstruction in areas already complete. This Work may involve the removal of ceiling tiles or the cutting and patching of walls.

d. No labor costs shall be included for the following items since the labor is already covered by the NECA labor units for conduit and construction channel:

1) Conduit straps and clips.

2) Construction channel accessories (nuts, washers, etc.).

3) Screws.

4) Conduit elbows ¾" and smaller.

2. Material:

a. The cost of material shall be the direct cost, including sales tax and may include the cost of transportation from the Supplier to the Contractor, but charges for final delivery to the Project site will not be allowed.

b. Electrical commodities priced based on most current Trade Service Book with a 15% discount. Non-commodities priced per invoice from Supplier.

3. Equipment rental:

a. Payment for equipment costs will be made at the rental rates listed for such equipment as specified in the current edition, at the time of the Work, of "Labor Surcharge and Equipment Rental Rates," a Caltrans Publication. Such rental rates shall be adjusted as appropriate and will be used to compute payments for equipment; regardless of the whether the equipment is under Contractor's control through direct ownership, leasing, renting or other method of acquisition. Daily, weekly, or monthly rates shall be used, whichever is lower. Hourly rates including operator shall not be used.

b. The actual time to be paid for equipment shall be the time the equipment is in productive operation on the Work. No payment will be made time while equipment is inoperative due to breakdown or for non-working days.

c. Individual pieces of equipment having a replacement value of $1,000 or less shall be considered small tools or small equipment and no payment will be made since the costs of these tools and equipment are included as part of the Contractor's mark-up for overhead and profit.

d. Payment to Contractor for use of equipment as set forth herein shall constitute full compensation to Contractor for the cost of fuel, power, oil, lubricants, supplies, small equipment, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, labor (except for equipment operators) and any and all costs to Contractor for incidental use of the equipment.

4. Performance bond: Only the actual cost of insurance and bond premiums, with no mark-up for overhead and profit, will be allowed.

C. Mark-up for overhead and profit on direct costs:

1. Costs to be included as part of mark-up:

a. Field and home office personnel including, but not limited to, Principals, Project Managers, Superintendents, Supervisory Foremen, Estimators, Project Engineers, Detailers, Draftspersons, Schedulers and Administrative Assistants.

b. All field and home office expenses including, but not limited to, field trailers, parking, storage sheds, office equipment and supplies, telephone service at the Project site, long-distance telephone calls, fax machines, computers and software, temporary utilities, sanitary facilities, etc.

c. Administrative functions including, but not limited to, reviewing, coordinating, distributing, processing, posting, recording, estimating, negotiating, scheduling, schedule updating and revising, expediting, detailing, revising Shop Drawings and preparing Record Drawings.

d. Vehicles required for the transportation of Contractor's staff and field personnel.

2. Maximum mark-up values:

a. For Work performed by the Contractor, the overhead mark-up shall equal a maximum of 10 percent of the direct costs, as defined herein.

b. Mark-up for profit shall equal a maximum of 5 percent of combined direct and overhead costs.

c. For Work performed by a Subcontractor shall equal a maximum of 5 percent mark-up for profit. Subcontractor shall follow the same guidelines above for their mark-up allowance. No consideration shall be given for more mark-ups then this two-tier arrangement whereas the mark-up could excess 20%.

d. For Work scope changes that result in a net decrease in cost to the Contractor or a Subcontractor, the Owner shall receive a credit based on the actual net decrease in direct cost figured in the same manner as an add cost. It is understood that the mark-up value applied at bid time will not be credited back. Although, if this is a change to a previous change order, then mark-up values shall be included in credit back to Owner.

e. There will be no mark-ups on the cost of performance bond.

D. Documentation:

1. Project change order request submission:

a. Provide copies of all take-off sheets showing material and labor charges in line item format.

b. Provide recap sheet showing all direct costs and mark-ups.

c. Provide copies of invoices for Subcontracted Work.

2. Allowance account tracking:

a. Contractor shall prepare and maintain a spreadsheet for each allowance account to track and monitor the requested and approved charges.

b. Copies of these spreadsheets, along with the summary spreadsheets, shall be submitted to the Owner's Representative twice a month.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 EXCAVATION

A. General: Cutting and digging shall be under the direct supervision of the General Contractor and included as necessary for the Work of this Section.

B. Excavation for underground vaults and electrical structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10-foot; plus, a sufficient distance to permit placing and removal of concrete formwork, installation or services, other construction and for inspection.

1. Excavate, by hand, areas within dripline of large trees. Protect the root system for damage and dry-out. Maintain moist conditions for root system and over exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

C. Trenching: Excavate trenches for electrical installation as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearances on both side of raceways and equipment.

2. Excavate trenches to depth indicated or required.

3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.

D. Backfilling: Place soil materials in layers to required subgrade elevations for each area classification, using materials and methods specified in Division 31, Earthwork.

1. Under building slabs, use drainage fill materials.

3.02 ROUGH-IN

A. Contractor shall verify lines, levels and dimensions indicated on the Drawings and shall be responsible for the accuracy of the setting out of Work and for its strict conformance with existing conditions at the Project site.

B. Verify final locations for rough ins with field measurements and with the requirements for the actual equipment to be connected.

C. Refer to equipment specification in Divisions 22 through 33 for rough-in requirements.

3.03 ELECTRICAL INSTALLATION

A. Preparation, sequencing, handling, and installation shall be in accordance with Manufacturer's written instructions and technical data particular to the product specified and/or accepted equal except as otherwise specified. Comply with the following requirements:

1. Shop Drawings prepared by Manufacturer.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting height is not detailed or dimensioned, contact the Architect for direction prior to proceeding with rough-in.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are indicated only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Coordinate electrical systems, equipment, and materials installations with other building components.
12. Provide access panel or doors where devices or equipment are concealed behind finished surfaces. Furnish and install access doors per the requirements of Division 08.
13. Install systems, materials and equipment giving right-of-way priority to other systems that are required to maintain a specified slope.
14. Conform to the National Electrical Contractors Association "Standard of Installation" for general installation practice.

3.04 CUTTING, PATCHING, PAINTING AND SEALING

A. Structural members shall in no case be drilled, bored, or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect and Structural Engineer.

B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

C. Cut, remove, and legally dispose of selected electrical equipment, components and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.

D. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Patch existing surfaces and building components using experienced installers and new materials matching existing materials and the original installation. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.

G. Application of joint sealers:

1. General: Comply with joint sealer Manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

2. Installation of fire-stopping sealant: Install sealant, including forming, packing and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops and fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.05 FIELD QUALITY CONTROL

A. General testing requirements:

1. The purpose of testing is to ensure that all tested electrical equipment, both Contractor and Owner supplied, is operational and within industry and Manufacturer’s tolerances and is installed in accordance with design Specifications.

2. Tests and inspections shall determine suitability for energization.

3. Perform tests in presence of the Owner's Representative and furnish test equipment, facilities and technical personnel required to perform tests.

4. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.

B. Tests: In addition to specific system test described elsewhere, tests shall include:

1. Equipment operations: Test motors for correct operation and rotation.

2. Lighting control circuits: Test lighting circuits for correct operation through their control devices.

3. Alarm and interlock systems: Produce malfunction symptoms in operating systems to test alarm and interlock systems. In addition, all specific tests described in the fire alarm system shall be performed.
4. Circuit numbering verification: Select on a random basis, various circuit breakers within the panelboards and cycle them on and off to verify compliance of the typed panel directories with actual field wiring.
5. Voltage check:
    a. At completion of job, check voltage at several points of utilization on the system that has been installed under this Contract. During test, energize all installed loads.
    b. Adjust taps on transformers to give proper voltage, which is 118 to 122volts for 120volt nominal systems and proportionately equivalent for higher voltage systems. If proper voltage cannot be obtained, inform the Owner and the serving Utility Company.

C. Contractor shall provide test power required when testing equipment before service energization and coordinate availability of test power with General Contractor after service energization. The Contractor shall provide any specialized test power as needed or specified herein.

D. Testing safety and precautions:
1. Safety practices shall include the following requirements:
    a. Applicable State and Local safety operating procedures.
    b. OSHA.
    c. NSC.
    d. NFPA 70E.
2. All tests shall be performed with apparatus de-energized and grounded except where otherwise specifically required ungrounded by test procedure.

E. Calibration of test equipment:
1. Testing Agency shall have calibration program that assures test instruments are maintained within rated accuracy.
2. Instruments shall be calibrated in accordance with the following frequency schedule:
    a. Field instruments: Analog, 6-months maximum; Digital, 12-months maximum.
    b. Laboratory instruments: 12-months.
    c. Leased specialty equipment: 12-months where accuracy is guaranteed by lessor.
3. Dated calibration labels shall be visible on test equipment.
4. Records, which show date and results of instruments calibrated or tested, must be kept up to date.
5. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.

6. Calibration standards shall be of higher accuracy than instrument tested.

7. Equipment used for field testing shall be more accurate than instrument being tested.

F. Coordinate with General Contractor regarding testing schedule and availability of equipment ready for testing.

G. Notify Owner and Engineer one week in advance of any testing.

H. Any products which fail during the tests or are ruled unsatisfactory by the Owner's Representative shall be replaced, repaired, or corrected as prescribed by the Owner's Representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.

I. Testing Agency shall maintain written record of tests and shall assemble and certify final test report.

J. Include all test results in the maintenance manuals.

3.06 CLEANING

A. Prior to energizing of electrical equipment, the Contractor shall thoroughly clean the interior of enclosures from construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.

B. Upon completion of Project, prior to final acceptance, the Contractor shall thoroughly clean both the interior and exterior of all electrical equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.

C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.07 PROJECT CLOSEOUT

A. Training:

1. At the time of completion, a period of not less than 4-hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This 4-hour training is in addition to any instruction time called out in the Specifications for specific systems. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with Manufacturer’s Representative. The equipment Manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.

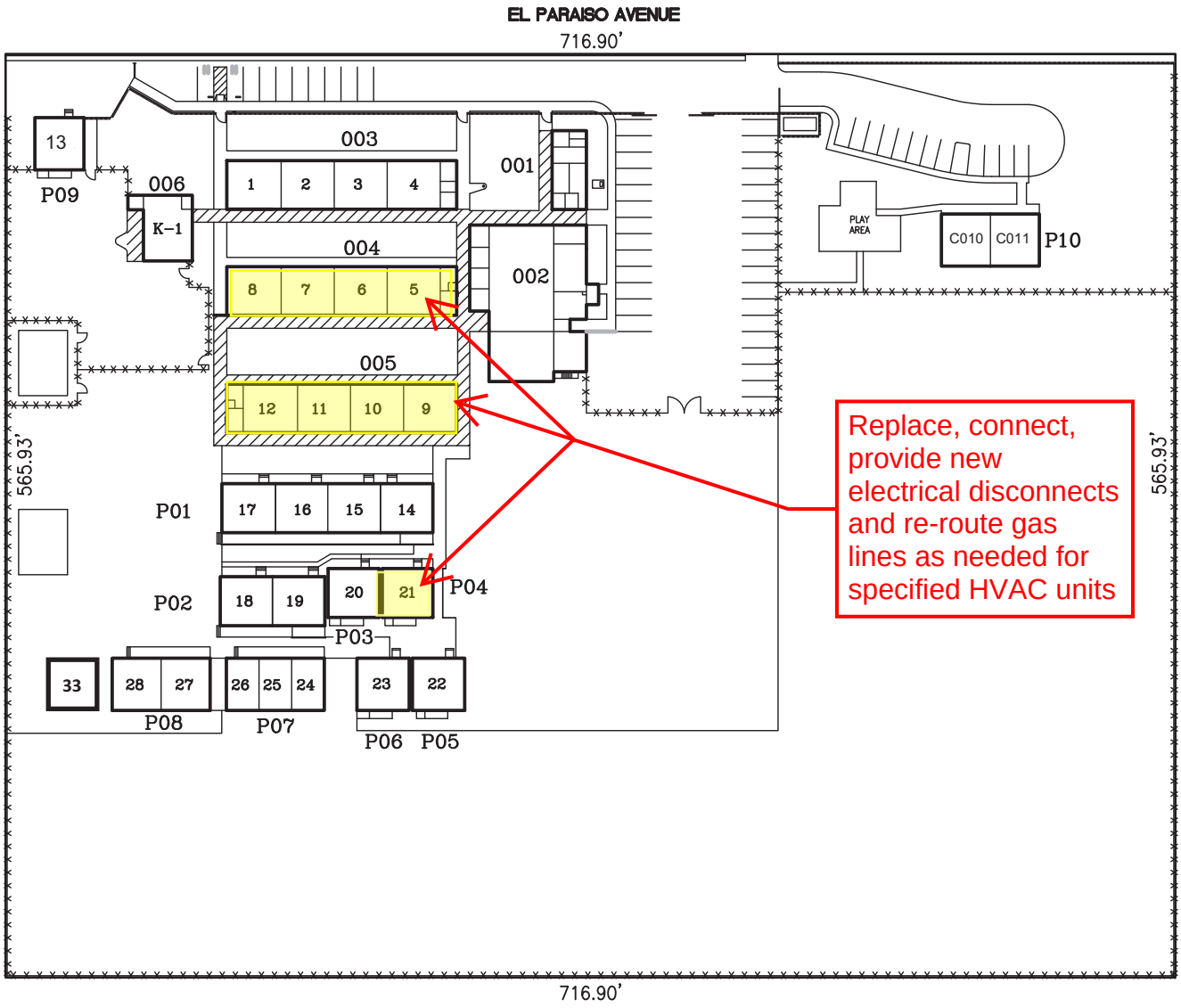
2. All training sessions shall be video recorded.

B. Special tools: Provide one of each tool type required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.

C. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF SECTION

CB WIRE HVAC REPLACEMENT



NORTH

Scale 1"=100'

SITE AREA: 9.34 ACRES
A.P.N. 037-0231-005

040 - Clayton B. Wire Elementary School
5100 El Paraiso Avenue
SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

EXISTING SITE DIAGRAM

OCTOBER 2001