SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Heating water piping.
2. Condensate water piping.
3. Equipment drains and over flows.
4. Unions and flanges.
5. Pipe hangers and supports.
6. Valves.

B. Related Sections:

1. Division 07 - Firestopping: Product requirements for firestopping for placement by this section.
2. Division 08 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Division 09 - Painting and Coating: Product requirements Painting for placement by this section.
4. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product and execution requirements for expansion compensation devices use in heating and cooling piping systems.
5. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves for placement by this section.
6. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
7. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
8. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties used in heating and cooling piping systems.
9. Section 23 21 23 - Hydronic Pumps: Product and execution requirements for pumps used in heating and cooling piping systems.
10. Section 23 25 00 - HVAC Water Treatment: Product and execution requirements for cleaning and chemical treatment of heating and cooling piping systems.
11. Division 32 - Base: Aggregate for backfill in trenches.
12. Division 31 - Grading: Product and execution requirements for excavation, backfill and trenching required by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B31.1 - Power Piping.

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6. ASME B31.9 - Building Services Piping.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM A395 - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
7. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
8. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
9. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
10. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
11. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
12. ASTM D2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
13. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
14. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
15. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
17. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
18. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
19. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
20. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
21. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
22. ASTM D3309 - Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems.
23. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
24. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
25. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
26. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

27. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
28. ASTM F845 - Standard Specification for Plastic Insert Fittings for Polybutylene (PB) Tubing.
29. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
30. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot-and Cold-Water Distribution Systems.
31. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:

1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 67 - Butterfly Valves.
3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
4. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
5. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
6. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
7. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
8. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
9. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
10. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Provide pipe hangers and supports in accordance with ASME B31.1, ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

D. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Use globe, ball or butterfly valves for throttling, bypass, or manual flow control services.

F. Use spring loaded check valves on discharge of hot water pumps.

G. Use plug valves for throttling service. Use non-lubricated plug valves only when shut-off or isolating valves are also provided.

H. Use lug end butterfly valves to isolate equipment.

I. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

J. Flexible Connectors: Use at or near pumps, and motor driven equipment where piping configuration does not absorb vibration.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate schematic layout of all piping systems, including equipment, critical dimensions, and sizes.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.

D. Test Reports: Indicate results of piping system pressure test.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX or AWS D1.1.

H. Acceptance or no exceptions taken by the engineer on any substitution proposed by the contractor shall not be construed as relieving the contractor from compliance with the project's specifications and performance requirements nor departure there from. The contractor remains responsible for details and accuracy for confirming and correlating quantities and dimensions and for the selection of fabrication processes, techniques and assembly, coordination of his work with that of all other trades and making any needed modifications consequent to the substitution at his own cost and for performing the work in a safe manner.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves equipment and accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.1 or ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.

C. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

1.08 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Division 01 - Administrative Requirements: Requirements for coordination.

B. Coordinate trenching, excavating, bedding and backfilling of buried piping systems.

1.13 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for valves excluding packing.

1.14 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two packing kits for each size and valve type.

PART 2 PRODUCTS

2.01 HEATING WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black.

1. Fittings: ASME B16.3, malleable iron or ASTM A234, forged steel welding type.
2. Joints: Threaded for pipe 2 inches and smaller; welded for pipe 2-1/2 inches and larger.

B. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.02 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53 Schedule 40, galvanized.

1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
2. Joints: Threaded for pipe 2 inches and smaller; flanged for pipe 2-1/2 inches and larger.

B. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.03 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with brazed joints.

3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
4. PVC Piping: PVC.
5. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.04 GATE VALVES

A. Gate Valves 2 inch and Smaller: MSS SP-80; Class 150, body and union bonnet of ASTM B62 cast bronze; with threaded or solder ends, solid disc, copper silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron hand wheel. Do not use solder end valves for hot water heating or steam piping applications.

Manufacturer	Threaded NRS	Threaded RS	Solder NRS	Solder RS
Crane	X	431UB	X	X
Grinnell	3050	3060	X	X
Hammond	IB637	IB629	X	IB68
Jenkins	X	47U	X	X
Lunkenheimer	3153	3151	3154	3155
Milwaukee	X	1151	X	1169
Powell	2712	2714	X	1842
Stockham	B-130	B-120	X	B-124
Nibco	T-136	T-134	X	S-134

1. X - means not available

B. Gate Valves, 2-1/2 inch and Larger: MSS-SP-70; Class 150 iron body, bronze mounted, with body and bonnet conforming to ASTM A126 Class B; with flanged ends, "Teflon" impregnated packing, and two piece backing gland assembly.

Manufacturers	OS&Y	NRS
Crane	465-1/2	461
Grinnell	6020A	6060A
Hammond	IR1140	IR1138
Jenkins	651A	326
Lunkenheimer	1430	1428
Milwaukee	F-2885	F-2882
Stockham	G-623	G-212
Powell	1793	1787
Nibco	F-6170	F-619

2.05 GLOBE VALVES

A. Globe Valves, 2 inch and Smaller: MSS SP-80; Class 150; body and screwed bonnet of ASTM B62 cast bronze; with threaded or solder ends, brass or replaceable composition disc, copper silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron hand wheel. Provide Class 150 valves meeting the above where system pressure requires, and for all heating hot water with threaded ends.

Manufacturer	Threaded	Solder	Threaded
Crane	1	1310	17TF
Grinnell	3210	3210SJ	3240
Hammond	IV440	IB423	IB413T
Jenkins	746X	1200	106-A-2
Lunkenheimer	2140	2146	407
Milwaukee	502X	1502	590
Powell	6502712	1823	150
Stockham	B-16	B-14T	B-22

B. Globe Valves, 2-1/2 inch and Larger: MSS SP-85; Class 150 iron body with bolted bonnet conforming to ASTM A126, Class B; with outside screw and yoke, bronze mounted, flanged ends, and "Teflon" impregnated packing, and two piece backing gland assembly.

Manufacturer	Straight Body	Angle Body
Crane	351	353
Grinnell	6200A	X
Hammond	IR116	IR118
Jenkins	613	X
Lunkenheimer	1123	1124
Milwaukee	F2981	F2986
Powell	241	243
Stockham	G-512	G-515

1. X - means not available.

2.06 BALL VALVES

A. Ball Valves, 2-1/2 inch and Smaller: Rated for 150 psi saturated steam pressure, 600 psi WOG pressure; two-piece construction; with bronze body conforming to ASTM B62, full port, chrome plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl covered steel handle.

Manufacturer	Threaded Ends	Solder Ends
Conbraco (Apollo)	70-100	70-200
Crane	9302	9322
Grinnell	3500	3500 SJ
Jamesbury	351	X
Jenkins	900T	902T
Lunkenheimer	708HST	X
Metravlex	IT	IS
Powell	4210T	X
Stockham	S-216 BR-R-T	S-216 BR-R-S

Manufacturer	Threaded Ends	Solder Ends
Watts	B-6000	B-6001
Nibco	T-585-70	S-585-70

1. X - means not available.

B. Ball Valves 1-1/4 inch to 2-1/2 inch: Rated for 150 PSI saturated steam pressure, 600 PSI WOG pressure; 3 piece construction; with bronze body conforming to ASTM B62, conventional port, chrome plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blow out proof stem, and vinyl covered steel handle. Provide threaded ends for chilled water and heating hot water service.

Manufacturer	Threaded Ends	Solder Ends
Grinnell	3800	3800SF
Nibco	T-595-Y	S-595-Y

2.07 BUTTERFLY VALVES

A. Butterfly Valves, 2-1/2 inch and Larger: MSS SP-67; rated at 200 psi, ductile iron body conforming to ASTM A536, Class B. Provide valves with field replaceable EPDM sleeve, nickel aluminum bronze disc, stainless steel stem, and EPDM O-ring stem seals. Provide lever operators with locks for sizes 2 – 6 inch and gear operators with position indicator for sizes 8 – 24 inch. Provide lug type. Drill and tap valves on dead end service or requiring additional body strength.

1. The following are model numbers for lug type with aluminum bronze disc:

Manufacturer	Lever	Gear
Center Line	Series LT	Series LT
Crane	44	44
Conbraco (Apollo)	6L-14X-01	6L-14X-02
Grinnell	LD-8289-7	LD-8282-7
Keystone	129	129
Mueller	56INK-6	INK-6
Powell	5011-BA-1	5011-BA1
Stockham	LG-712-BS3E	LG-722-BS3E
Watts	BF-03-121-11	BF-03-121-12

2.08 CHECK VALVES

A. Swing Check Valves, 2 inch and Smaller: MSS SP-80; Class 125, cast bronze body and cap conforming to ASTM B62; with horizontal swing, Y-pattern and bronze disc; and having threaded or soldered ends. Provide valves capable of being reground while the valve remains in the line. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires and for all heating hot water.

Manufacturer	Class 125 Threaded Ends	Class 125 Solder Ends	Class 50 Threaded Ends
Crane	37	1342	137
Grinnell	3300	3300SJ	3320
Hammond	IB940	IB941	IB946
Jenkins	92-A	1222	92-A

Manufacturer	Class 125 Threaded Ends	Class 125 Solder Ends	Class 50 Threaded Ends
Lunkenheimer	2144	2145	230-70
Milwaukee	509	1509	510
Powell	587	1825	596
Stockham	B-319	B-309	B-321

1. Use 316 stainless steel check valve, rated at 200 psi for clean steam system.

B. Swing Check Valves, 2-1/2 inch and Larger: MSS SP-71; Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal wing, and bronze disc or cast iron disc with bronze disc ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line.

Manufacturer	Class 125	Class 175
Crane	373	X
Grinnell	6300A	X
Hammond	IR1124	X
Jenkins	X	729
Kennedy	X	Fig 126
Lunkenheimer	179 IBBM	X
Milwaukee	F2974	X
Powell	559	X
Stockham	G-931	G-940

1. X - means not available.

C. Lift Check Valves, 2 inch and Smaller: Class 125; cast bronze body and cap conforming to ASTM B62; horizontal or angle pattern, lift type valve with stainless steel spring, bronze disc holder with renewable "Teflon" disc, and threaded ends. Provide valves capable of being refitted and ground while the valve remains in the line.

Manufacturer	Horizontal	Angle
Hammond	X	IB954
Jenkins	655-A	X
Lunkenheimer	233	X
Mueller	303-BP	X

1. X - means not available.

D. Globe (Flanged) Style Silent Check Valves: 2 inch and larger Class 250, cast iron body; with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately 1 foot differential pressure.

Check Valves	
Grinnell	502 ½ - 580
Mueller	109 MAP

2.09 BACKFLOW PREVENTERS

A. Reduced pressure principle assembly consisting of shut off valves on inlet and outlet and strainer on inlet. Assemblies shall include test cocks and pressure differential relief valve located between 2 positive seating check valves and comply with requirements of ASSE Standard 1013. Assemblies shall have approval of the Health Department having jurisdiction.

Backflow Preventers
Cla-Val Co.
Febco
Hersey Products, Inc.
Watts Regulator Co.
Zurn Industries Inc., Wilkins Regulators Div.

2.10 Y-TYPE STRAINERS

A. Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens shall be Type 304 stainless steel, with 3/64 inch perforations at 233 per square inch.

1. All strainers shall be furnished with a 3/4 inch ball valve with a hose adapter for blowing down.
2. Provide strainers with 125 PSI working pressure rating for low-pressure applications, and 250 PSI pressure rating for high pressure application.
3. Threaded Ends 2 inch and Smaller: Cast iron body, screwed screen retainer with centered blow down fitted with pipe plug.
4. Threaded Ends 2-1/2 inch and Larger: Cast iron body, bolted screen retainer with off center blow down fitted with pipe plug.
5. Flanged Ends 2 inch and Larger: Cast iron body, bolted screen retainer with off-center blow down fitted with pipe plug.
6. Butt Welded Ends 2-1/2 inch and Larger for Low Pressure Application: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blow down fitted with pipe plug.
7. Butt Welded Ends 2-1/2 inch and Larger for High Pressure Application: Schedule 80 cast carbon steel body, bolted screen retainer with off center blow down fitted with pipe plug.

2.11 CATHODIC PROTECTION

A. Shall be provided to control corrosion of all buried metallic pipe. Attach anodes to all underground steel piping with isolated unions in accordance with accepted practice.

2.12 SEISMIC EXPANSION LOOP

A. Seismic expansion loop shall be Metraloop as manufactured by Metraflex Company with sizes noted on the drawings, or equal by Unisource shall be installed wherever piping crossed seismic joints in building.

B. The loop shall consist of two flexible sections of hose and braid, taco ninety degree elbows and a 180 degree return.

C. Loops shall be installed in a neutral, precompressed, or pre-extended condition as required for the application.

D. Loops installed hanging down shall have a drain plug. Loops installed straight-up shall be fitted with an automatic air release valve at the highest point of the loop. Follow manufacturer's installation instructions.

E. Hose and braid material shall be Series 300 stainless steel.

F. Hose and braid material for 2" and smaller copper pipe shall be bronze.

2.13 PIPE HANGERS AND SUPPORTS

A. Refer to Division 23 05 29Hangers and Supports for HVAC and Plumbing Piping and Equipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems.

3.03 INSTALLATION - PIPING

A. General:

1. Furnish and install all piping, equipment trim, etc., including all work necessary to make complete and properly operating systems, whether or not all details are mentioned in these specifications or indicated on the drawings.
2. Rough-in work: Pipe sizes shown on the drawings are nominal inside diameter except copper tubing for refrigerant service which is outside diameter. Wherever five inch size pipe is shown, six inch may be substituted. Unless noted otherwise, make all pipe trim full line size.
3. Proceed as rapidly as the building construction will permit, so as to be completed, tested and approved before being enclosed.
4. Carefully inspect each piece of pipe and each fitting to see that there is no defective workmanship on the pipe or obstructions or dirt in the pipes and fittings. Material having burrs, slag intrusions, cracks, eccentricity, excessive roughness, damage due to rough handling, etc., will be rejected and shall be removed from the job site.

5. Whenever work is not in progress and at the end of each workday, cap or plug all openings in completed piping to prevent the entrance of materials that would obstruct the pipes. Leave in place until removal is necessary for completion of installation.
6. No piping shall be permanently closed up, furred in, or covered over before it has been tested and inspected as specified herein by the appropriate team members and is accepted by the Architect.
7. Install piping parallel to walls and to present a neat appearance both as to workmanship and grouping.
8. Piping shall clear all obstructions, preserve headroom and keep openings and passageways clear whether shown on the plans or not.
9. Should structural difficulties prevent the running of pipes or the setting of equipment at the point indicated by drawings, the necessary minor deviations therefrom, as determined by the Architect will be allowed, but must be made without additional cost.
10. Locate piping to clear steel reinforcing bars in beams. Offset reinforcing bars in walls to clear piping and sleeves. Get approval from Structural Engineers. Joists, girders, beams, columns or reinforcing steel shall not be cut or weakened. No holes shall be drilled or bored in structural members without obtaining permission from the Structural Engineer.
11. Conceal all piping within the building wherever possible, unless otherwise noted on drawings. Exposed piping, wherever necessary, shall if possible be run in unfinished rooms.
12. Do not use couplings except where required pipe runs between fittings that are longer than a standard length of the type of pipe being used and except where their use is specifically approved by the Architect.
13. Copper, bronze, and brass solder type fittings, including unions and flanges, shall have sockets of proper diameters to suit outside diameters of copper and brass pipe and copper tubing with which they are being used. The expanding or swaging of tubing to fit IPS fitting sockets will not be permitted.
14. Cut pipe accurately to measurements established at the site. All pipe cut on the project will be fully reamed and deburred at the time of cutting. Work all pipe and fittings into place without springing or forcing. Properly clear all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipe that must be sprung to make up on the Countys projects will be removed and replaced at no cost to the County.
15. Pipe damage: Show no tool marks or threads on exposed plated, polished or enameled connections to fixtures. Tape finished surfaces to prevent damage during plastering. Brass and copper piping shall have no tool marks wherever installed.
16. Make all changes in direction with fittings and changes in main size with reducing fittings. Unless otherwise noted, for pipe size change on all horizontal pump circulated water supply and return piping, use eccentric couplings flat on top.
17. Provide dielectric insulation at all points where copper water piping including brass nipples in same, is connected to ferrous metal such as steel piping, tanks, water heaters, etc.
18. Pitch pipe lines to be free of sags, traps or unnecessary bends as required for proper drainage. Provide a gate valve of same size as line but 3/8" minimum and 3/4" maximum size at each low point and each high point with vacuum breakers.
19. For expansion and contraction of heated or cooled piping, provide sufficient swing joints, ball joints, expansion loops, and devices necessary for a flexible piping system, whether shown or not shown on drawings. Anchors shall be constructed of structural shapes. Submit details to the Architect.
20. Support piping independently at pumps, coils, tanks, and other equipment so that its weight will not be supported by the equipment. Piping must align at equipment such that the interface in stress free.
21. Unions and Flanges.
    a. Provide unions or flanges suitably located to facilitate maintenance and removal of all equipment or automatic pipe mounted apparatus.

b. Faces of flanges to be connected shall, in all cases, be alike.
c. Provide two unions at threaded three way mixing valves.

22. Shop or field fabricated fittings, bushings, street ells, and long screw nipples are not acceptable and shall not be used. Reducer couplings, tees or ells shall not be used.
23. Springing, bending or forcing of pipe into place shall not be allowed. Use fittings for all off-sets or changes in alignment of piping.
24. Provide flexible piping connection on each pipe connection to equipment mounted on, or suspended from, isolators with one half inch or more static deflection or where such connections are shown on plans.

3.04 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.05 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708 and MSS SP 89.

B. Support horizontal piping as scheduled.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

H. Provide copper plated hangers and supports for copper piping or sheet lead packing between hanger or support and piping.

I. Prime coat exposed steel hangers and supports. Refer to Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

K. Install pipe hangers and supports in accordance with Division 23.

3.06 VALVE ENDS SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2 inch and Smaller: Solder ends, except provide threaded ends for heating hot water and low-pressure steam service.
2. Steel Pipe Sizes, 2 inch and Smaller: Threaded end.
3. Steel Pipe Sizes, 2-1/2 inch and Larger: Flanged end.

3.07 VALVE INSTALLATIONS

A. General Application: Refer to piping system specification sections for specific valve applications and arrangements. Use gate, ball, and butterfly valves for shut-off duty; globe and ball for throttling duty.

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

C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

D. Install three-valve bypass around each pressure reducing valve using throttling type valves.

E. Install valves in horizontal piping with stem movement.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Lift Check Valve: With stem upright and plumb.

3.08 SOLDER CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and glove valves to full open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of flux.

G. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

H. Use 95-5 tin/antimony solder for all solder joints unless indicated otherwise.

3.09 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.10 FLANGED CONNECTIONS

A. Align flanged surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.11 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and 01 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.12 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

A. Valves, 2 inch and Smaller:

Service	Gate	Globe	Ball	Check
Domestic Hot and Cold Water, Heating Hot Water	150	150	150	150

B. Valves, 2-1/2 inch and Larger:

Service	Gate	Globe	Ball	Check
Domestic Hot and Cold Water	125	125	200	125
Heating Hot Water	150	150	200	125

C. Valve Service:

1. Heating Hot Water Piping
2. Condenser Water Piping
3. Equipment Drains and Overflows

END OF SECTION

SECTION 23 21 16

HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Positive displacement meters.
2. Heat consumption meters.
3. Liquid flow meters.
4. Pressure gages.
5. Pressure gage taps.
6. Thermometers.
7. Thermometer supports.
8. Test plugs.
9. Flexible connectors.
10. Bladder-type expansion tanks.
11. Air vents.
12. Air separators.
13. Strainers.
14. Pump suction fittings.
15. Combination pump discharge valves.
16. Flow controls.
17. Flow meters.
18. Relief valves.
19. Escutcheons.
20. Unions
21. Dielectric union.
22. Dielectric waterway.
23. Flexible ball joints.

B. Related Sections:
1. Section 23 21 13- Hydronic Piping: Execution requirements for piping connections to products specified by this section.
2. Section 23 21 23- Hydronic Pumps: Execution requirements for piping connections to products specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

C. American Water Works Association:
1. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
2. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
3. AWWA C702 - Cold-Water Meters - Compound Type.
4. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
5. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

D. Underwriters Laboratories Inc.:
   1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
   2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.03 PERFORMANCE REQUIREMENTS

A. Flexible Connectors: Provide at or near pumps, motorized equipment and where piping configuration does not absorb vibration.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for manufactured products and assemblies used in this Project.
   1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
   2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
   3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
   4. Submit electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Acceptance or no exceptions taken by the engineer on any substitution proposed by the contractor shall not be construed as relieving the contractor from compliance with the project's specifications and performance requirements nor departure there from. The contractor remains responsible for details and accuracy for confirming and correlating quantities and dimensions and for the selection of fabrication processes, techniques and assembly, coordination of his work with that of all other trades and making any needed modifications consequent to the substitution at his own cost and for performing the work in a safe manner.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and instrumentation, flow controls, and flow meters.

C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements.

B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.10 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

1.11 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

1.12 MAINTENANCE SERVICE

A. Division 01 - Execution and Closeout Requirements: Maintenance service.

1.13 MAINTENANCE MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance materials.

1.14 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.01 POSITIVE DISPLACEMENT METERS (LIQUID)

A. AWWA C700, AWWA C701, AWWA C702, positive displacement disc type suitable for fluid with bronze case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading to AWWA C706.

B. Meter: Brass body turbine meter with magnetic drive register.
   1. Service: Cold water, 122 degrees F, Hot water, 200 degrees F.
   2. Nominal Flow: As indicated on the drawings.
   3. Pressure Drop at Nominal Flow: As indicated on the drawings.
   4. Maximum Flow: As indicated on the drawings.
   5. Maximum Operating Pressure: 250 psi.
   6. Accuracy: 1-1/2 percent.
   7. Maximum Counter Reading: 10 million gallons.
   8. Pipe Size: As indicated on the drawings.

2.02 HEAT CONSUMPTION METERS

A. Meter: Brass body turbine meter with magnetic drive register, platinum temperature sensors.
   1. Maximum Service Temperature: 200 degrees F.
   2. Nominal Flow: As indicated on the drawings.
   3. Pressure Drop at Nominal Flow: As indicated on the drawings.

4. Maximum Flow: As indicated on the drawings.
5. Maximum Operating Pressure: As indicated on the drawings.
6. Accuracy: 1-1/2 percent.
7. Maximum Counter Reading: 1 million btuh.
8. Pipe Size: As indicated on the drawings.
9. Power: 24 volt converter.

2.03 LIQUID FLOW METERS

A. Measuring Station: Type 316 stainless steel Pitot type flow element with safety shut-off valves and quick coupling connections.
   1. Support: Inserted through welded threaded couplet with isolation valve and insert-retract mechanism.
   2. Pressure rating: 275 psi.
   3. Maximum temperature: 400 degrees F.
   4. Accuracy: Plus 0.55 percent to minus 2.30 percent.
   5. Labeling: Metal tag indicating design flow rate, reading for design flow rate, metered fluid, line size, station or location number.

B. Meter Set: Dry single diaphragm type gage with magnetic drive, 2-1/2 inch x 6 inch dial, stainless steel wetted metal parts, and direct reading of flow rate, with two 10 foot long nylon test hoses with fittings.

C. Portable Meter Set: Dry single diaphragm type gage with magnetic drive, 2-1/2 inch x 6 inch dial, stainless steel wetted metal parts, and direct reading of flow rate. Mounted in rust-proof carrying case with two 10 foot long rubber test hoses with brass valves or quick connections for measuring stations.

2.04 PRESSURE GAGES

A. Manufacturers:
   1. Ametek, U.S. Gauge Div.
   2. Ashcroft Dresser Industries Instrument Div.
   3. Marsh Instruments Co., Unit of General Signal
   4. Marshalltown Instruments, Inc.
   5. Miljoco Corp.
   6. Trerice (H.O.) Corp.
   7. Weiss Instruments Corp.
   8. WIKA Instruments Corp.
   9. Substitutions: Division 01 - Product Requirements.

B. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon tube type, bottom connection.

C. Case: Stainless steel or brass, acrylic lens, 4-1/2 inch diameter.

D. Connector: Brass, 1/4 inch NPT.

E. Scale: Aluminum with white finish and black markings.

F. Accuracy: +1% of range span.

G. Range: Conform to the following:
   1. Vacuum: 30 inch and 0-15 psi compound range; 1 inch and 1/2 PSI graduations.
   2. Chilled and heating water systems, except as otherwise indicated, 0-60 PSI range, 1 PSI graduation.
   3. Condenser water system, except as otherwise indicated: (0-15); (0-30) PSI range, (1/4 PSI); (1/2 PSI) graduation.
   4. Except as otherwise indicated: 0-100 PSI range, 1 psi graduation.

2.05 PRESSURE GAGE TAPS

A. Siphon: 1/4 inch NPT straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4 inch NPT brass bushing with corrosion resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

C. Ball Valve: Brass, for 250 psi.

2.06 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Marshalltown Instruments, Inc.
   2. Miljoco Corp.
   3. Trerice (H.O.) Corp.
   4. Weiss Instruments Corp.
   5. Weksler Instruments Corp.
   6. Substitutions: Division 01 - Product Requirements.

B. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.

C. Scale range: Temperature ranges for services listed as follows:
   1. Domestic Hot Water: 30 to 240 degree F with 2 degree F scale divisions
   2. Domestic Cold Water: 0 to 100 degree F with 2 degree F scale divisions
   3. Heating Water: 30 to 300 degree F with 2 degree F scale divisions
   4. Condenser Water: 0 to 160 degree F with 2 degree F scale divisions
   5. Chilled Water: 0 to 100 degree F with 2 degree F scale divisions
   6. Steam and Condensate: 50 to 400 degree F with 2 degree F scale divisions

D. Liquid In Glass Thermometers
   1. Case: Die cast, aluminum finished, in baked epoxy enamel, acrylic front, spring secured, 9 inches long.
   2. Adjustable Joint: Finished to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.
   3. Tube: Blue reading, non-toxic organic filled, magnifying lens.
   4. Scale: V-shaped aluminum with white finish and black markings.
   5. Stem: Copper plated steel, aluminum or brass for separable socket, length to suit installation.

E. Thermometer Wells: Stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.07 TEST PLUGS

A. Manufacturers:
   1. MG Piping Products Co.
   2. Miljoco Corp.
   3. Peterson Equipment Co.
   4. Sisco, A Spedco, Inc. Co.
   5. Trerice (H.O.) Co.
   6. Watts Regulator Co.
   7. Substitutions: Division 01 - Product Requirements.

B. Test plugs shall be nickel plated brass body, with 1/2" NPS fitting and 2 self sealing valve type core inserts suitable for inserting a 1/8" O.D. probe assembly from a dial type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 PSIG.

C. Core material shall conform to the following for fluids and temperature range: Air, Water, Oil and Gas, 20 to 2000 degrees F, neoprene.

D. Test Kit: Provide test kit consisting of 1 pressure gage, gage adapter with probe, 2 bimetal dial thermometers and carrying case.

E. Ranges of pressure gage and thermometers shall be approximately 2 times systems operating conditions.

2.08 FLEXIBLE CONNECTORS

A. Flexible Pipe Connectors: Spool type, flexible rubber connections with guide rods insulated with grommets and washers for 2 inch and over; minimum 150 psig working pressure, maximum 250 degree F operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of 3/4 inch misalignment

B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 200 psig at 250 degrees F.

2.09 DIAPHRAGM-TYPE EXPANSION TANKS

A. Manufacturers:
1. Bell & Gossett ITT, Fluid Handling Div.
2. Amtrol, Inc.
3. Armstrong Pumps, Inc.
4. Taco, Inc.
5. Substitutions: Division 01 - Product Requirements.

B. Size and number as indicated, constructed of welded carbon steel for 125 psig working pressure, 375 degree F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division I.

2.10 AIR VENTS

A. Manufacturers:
1. Bell & Gossett ITT, Fluid Handling Div.
2. Amtrol, Inc.
3. Armstrong Machine Works.
4. Hoffman Specialty ITT, Fluid Handling Div.
5. Spirax Sarco
6. Anvil International
7. Substitutions: Division 01 - Product Requirements.

B. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 225 degree F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge connection and 1/2 inch inlet connection.

2.11 AIR SEPARATORS

A. Manufacturers:
1. Bell & Gossett ITT, Fluid Handling Div.
2. Amtrol, Inc.
3. Armstrong Pumps, Inc.
4. Taco, Inc.
5. Substitutions: Division 01 - Product Requirements.

B. Air separator: Welded black steel; ASME constructed and labeled for minimum 125 psig water working pressure and 375 degree F operating temperature; perforated stainless steel air collector tube designed to direct released air into compression tank; tangential inlet and outlet connections; screwed connections up to and including 2 inch NPS; flanged connections for 1-1/2 inch NPS and above; threaded blowdown connection; size as indicated for full system flow capacity.

2.12 STRAINERS

A. Size 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

C. Size 5 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.13 PUMP SUCTION DIFFUSER FITTINGS

A. Manufacturers:
   1. Bell & Gossett
   2. Substitutions: Division 01 - Product Requirements.

B. Fitting: Angle pattern, cast-iron body. Threaded for 2 inches and smaller, flanged for 2-1/2 inch and larger. Rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.14 COMBINATION PUMP DISCHARGE VALVES (TRIPLE DUTY VALVES)

A. Manufacturers:
   1. Bell & Gossett
   2. Substitutions: Division 01 - Product Requirements.

B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.15 AUTOMATIC FLOW CONTROLS

A. Manufacturers:
   1. Griswold
   2. Substitutions: Division 01 - Product Requirements.

B. Automatic pressure compensating flow control valves shall have the capacities and pressure differential characteristics as indicated and conform to the following specifications.

C. Valves shall be factory set and shall automatically limit the rate of flow to required engineered capacity within ±5% accuracy over an operating pressure differential of at least 14 times the minimum required for control.

D. The control mechanism of the valve shall consist of a self-contained, open-chamber cartridge assembly with unobstructed flow passages that eliminate accumulation of particles and debris. All internal working parts shall be type 300 passivated stainless steel. No plated materials are acceptable.

E. The type 300 passivated stainless steel cartridge assembly shall consist of a spring-loaded cup. The cup shall be guided at two points and shall utilize the full available differential pressure across the valve to actuate the cup and thereby reduce friction and hysteresis and eliminate binding. It shall have a thin orifice plate for self-cleaning of the variable inlet ports over the full control range. Cartridge must be removable in one piece.

F. Valves shall be available in four pressure differential ranges, with the minimum range requiring less than 2 PSIG to control flow. Valve bodies shall be provided with inlet and outlet tappings suitable for connection of instruments for verification of flow rates, and shall marked to show direction of flow. Valve bodies shall be rated for use at not less than 150% of system designed operating pressure.

G. Certified performance data for the flow control valve, based on independent laboratory tests, supervised and witnessed by a registered professional engineer, shall be available.

H. Each automatic flow control valve shall be furnished with a valve kit consisting of 1/4 inch X 2 inch minimum size nipples, quick disconnect valves and fittings suitable for use with the measuring instruments specified.

I. Performance certification of valves, based on independent laboratory tests, shall be available.

J. Flow control valve shall be warranted for period of five years from date of original sale.

K. Valve shall be flanged type.

2.16 FLOW METERS

A. Manufacturers:
   1. Armstrong Pumps, Inc.
   2. Barco Div., Marison Industries
   3. Gerand Engineering Co.
   4. Substitutions: Division 01 - Product Requirements.

B. Flow rate of elements and meters shall be same as connected equipment or system.

C. Calibrated Plug Valves: 125 PSIG water working pressure, 250 degrees F maximum operating temperature, bronze body, plug valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valves 2 inches and smaller shall have threaded connections and 2-1/2 inch valves shall have flanged connections.

D. Venturi Type Flow Elements:
   1. Type: Differential pressure venturi type, designed for installation in piping.
   2. Construction: Bronze or cadmium plated steel with brass fittings and attached tag with flow conversion data. Ends shall be threaded for 2 inch and smaller elements and flanged or welded for 2-1/2 inch and larger elements.

E. Meters
   1. Portable meters: Differential pressure gage and two 12 foot hoses in carrying case with handle.
   2. Scale: In inches of water unless otherwise indicated.
   3. Accuracy: Plus or minus 2% between 20 to 80% of range.
   4. Each meter shall be complete with operating instructions.
   5. Provide two meters to the Owner.

2.17 RELIEF VALVES

A. Manufacturers:
   1. Bell & Gossett
   2. Substitutions: Division 01 - Product Requirements.

B. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.18 CHEMICAL FEEDER

A. Manufacturers:
   1. J. L. Wingert Co.
   2. Vulcan Laboratories, Subsidiary of Clow Corp.
   3. York-Shipley, Inc.
   4. Culligan USA

B. Chemical feeder: Bypass type chemical feeders of 5 gallons capacity, welded steel construction; 125 psig working pressure; complete with fill funnel and inlet, outlet and drain valves.

C. Chemicals shall be specially formulated to prevent accumulation of scale and corrosion in piping systems and connected equipment, developed based on a water analysis of make-up water.

2.19 ESCUTCHEONS

A. Chrome plated, stamped steel, hinged, split ring escutcheon, with setscrew. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

2.20 UNIONS

A. Malleable iron, Class 150 for low pressure service, and Class 250 for high pressure service; hexagonal stock, with ball and socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

2.21 DIELECTRIC UNIONS

A. Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

2.22 DIELECTRIC WATERWAY FITTINGS

A. Electroplated steel or brass nipple, with an inert and non-corrosive thermoplastic lining.

2.23 FLEXIBLE BALL JOINTS

A. Manufacturer's: ATS, Barco, or equal.

B. Type: The ball joints shall be the packaged type which allows for additional packing to be injected under full system pressure. The design is based on the Advanced Thermal Systems Inc. Series "P2" Thermal Pak Flexible Ball Joint.

C. Design:
   1. The ball joints shall be designed for 300 psig – 600 degrees F (steam, condensate, heating hot water, and chilled water) services.
   2. The ball joint shall have a one piece integral ball retainer socket. Designs which utilize bolts and a loose retainer flange are not acceptable.
   3. Ball joints shall be capable of +/- 7-1/2 degree flex and 360 degree rotation for sizes 2-1/2 inch and larger, and +/- 15 degree flex and 360 degree rotation for sizes 3/4 inch to 2 inch.

4. The ends of the ball joint shall be machined for welding to a standard wall pipe furnished with 150 lb raised face forged steel flanges.
5. The ball joint shall have 2 inch minimum diameter packing cylinders welded in place to allow packing to be injected under full line pressure. Packing cylinders shall have integral stainless steel safety valves.
6. The completed ball joint is to be flex tested by moving the ball through the full rated flex a minimum of three times to ensure torque values comply with published data. Forces are to be measured and recorded.

D. Materials
1. All pressure containing components shall be machined from either heavy wall mechanical tubing equivalent to A106 or forged A105 carbon steel. Castings are not to be used for any pressure containing component.
2. The spherical surface of the ball shall be plated with dual chrome, consisting of 1 mil minimum of industrial hard chrome over 1 mil minimum crack free hard chrome.
3. The compression seals are to be machined from ductile iron. Mineral filled composition seals are not to be used.
4. The ball joint is to be factory packed with flake graphite injectable packing for the intended service. Spare packing plugs are to be furnished with each ball joint.
5. To prevent by-pass of the injectable packing, the ball joints shall have a molded soft containment seal at each side of the injectable packing zone.
6. A removable reusable insulation blanket is to be provided with ball joint, and is to incorporate cut outs for access to the packing cylinders without removal of the blanket. The blanket is to match the thickness of the insulation on the mating pipe. The inner and outer covers of the blanket are to be made from silicone impregnated Nomex cloth. In addition, a stainless steel wire mesh liner is to be attached to the inside surface of the cover.

E. Installation: Installed per manufacturer's recommendations.

2.24 NON-FERROUS PIPE JOINTS.

A. Brazed and soldered joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0, Standard Code for Pressure Piping, Power Piping and ANSI B9.1, Standard Safety Code for Mechanical Refrigeration.

B. Thoroughly clean tube surface and inside surfaces of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4 inch and smaller.

2.25 OTHER JOINTS

A. Joints for other piping materials are specified within the respective piping systems sections.

PART 3 EXECUTION

3.01 INSTALLATION - METERS

A. Install positive displacement meters in accordance with AWWA M6, with isolating valves on inlet and outlet. Provide full line size bypass with globe valve for liquid service meters.

3.02 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage. Extend nipples to allow clearance from insulation.

D. Install pressure gages in piping tee with pressure gage valve, located on pipe at most readable position.

E. Install in the following locations, and elsewhere as indicated:
   1. At suction and discharge of each pump.
   2. At discharge of each pressure reducing valve.
   3. At building water service entrance.
   4. At chilled water inlets and outlets of chillers.

F. Pressure Gas Needle Valves: Install in piping tee with snubber. Install siphon in lieu of snubber for steam gages.

G. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

H. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.

I. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

J. Install in the following locations and elsewhere as indicated:
   1. At inlet and outlet of each hydronic boiler and chiller.
   2. At inlet and outlet of each hydronic coil in air handling units and built up central systems.

K. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

L. Coil and conceal excess capillary on remote element instruments.

M. Provide instruments with scale ranges selected according to service with largest appropriate scale.

N. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

O. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.03 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs adjacent to thermometers and thermometer sockets and adjacent to pressure gages and pressure gage taps. .

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide air separator on suction side of system circulation pump and connect to expansion tank.

F. Provide drain and hose connection with valve on strainer blow down connection.

G. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems where indicated on the drawings.

H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated on drawings.

I. Support pump fittings with floor mounted pipe and flange supports.

J. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

K. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

L. Pipe relief valve outlet to nearest floor drain.

M. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

3.04 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.

C. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not to be tested.

3.05 CLEANING

A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.

B. Flush system with clean water and clean the strainers.

3.06 PROTECTION OF INSTALLED CONSTRUCTION

A. Division 01 - Execution and Closeout Requirements: Requirements for protecting installed construction.

B. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. In-line circulators.
2. Base mounted pumps.

B. Related Sections:

1. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to pumps specified by this section.
2. Section 23 21 16 – Hydronic Piping Specialties
3. Division 26 - Equipment Wiring Connections: Execution requirements for electrical connections to pumps specified by this section.

1.02 REFERENCES

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters Laboratories Inc.:

1. UL 778 - Motor Operated Water Pumps.

1.03 PERFORMANCE REQUIREMENTS

A. Provide pumps to operate at system fluid temperatures indicated on Drawings without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

C. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience, and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for pumps.

1.11 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish one set of mechanical seals for each pump.

PART 2 PRODUCTS

2.01 IN-LINE CIRCULATORS

A. Manufacturers:

1. Bell & Gossett.

2. Armstrong.
3. Aurora.

B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig maximum working pressure.

C. Casing: Cast iron, with flanged pump connections.

D. Impeller: Stamped brass or cast bronze, keyed to shaft.

E. Bearings: Two, oil lubricated bronze sleeves.

F. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.

G. Seal: Carbon rotating against stationary ceramic seat, 212 degrees F maximum continuous operating temperature.

H. Drive: Flexible coupling.

I. Performance: Per Contract Drawings.

J. Electrical Characteristics and Components:

1. Electrical Characteristics: In accordance with Section 26 05 03:
2. Motors: In accordance with Section 21 05 13. 1750 rpm unless indicated otherwise.
3. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.02 BASE MOUNTED PUMPS

A. Manufacturers:

1. Bell & Gossett.
2. Armstrong.
3. Aurora.

B. Type: Horizontal shaft, single stage, direct connected, radial or horizontal split casing, for 125 psig maximum working pressure.

C. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

D. Impeller: Bronze, fully enclosed, keyed to shaft.

E. Bearings: Grease lubricated roller or ball bearings.

F. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

G. Seal: Carbon rotating against stationary ceramic seat, 212 degrees F maximum continuous operating temperature.

H. Drive: Flexible coupling with coupling guard.

I. Baseplate: Cast iron or fabricated steel with integral drain rim.

J. Performance: Per Contract Drawings.

K. Electrical Characteristics and Components:

1. Electrical Characteristics: In accordance with Section 26 05 03.
2. Motors: In accordance with Section 23 05 13. 1750 rpm unless specified otherwise.
3. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.

C. Install pumps on vibration isolators.

D. Install flexible connectors at or near pumps. Refer to Section 23 21 16.

E. Provide line sized shut-off valve and strainer or pump suction fitting on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve on pump discharge. Refer to Section 23 21 13 and Section 23 21 16.

F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.

G. Provide air cock and drain connection on horizontal pump casings.

H. Provide drains for bases and seals.

I. Check, align, and certify alignment of base mounted pumps prior to start-up.

J. Lubricate pumps before start-up.

3.02 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and Execution and Closeout Requirements.

B. Inspect for alignment of base mounted pumps.

3.03 SCHEDULES

A. Heating and Cooling Water Pumps: Per Contract Drawings.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Refrigerant piping.
   2. Unions, flanges, and couplings.
   3. Pipe hangers and supports.

B. Related Sections:
   1. Division 05 - Structural Steel Framing: Product requirements for touch-up painting of structural steel.
   2. Division 05 - Steel Joist Framing: Product requirements for touch-up painting of steel joists.
   3. Division 07 - Firestopping: Product requirements for firestopping for placement by this section.
   4. Division 08 - Access Doors and Frames: Access doors for concealed valves and accessories.
   5. Division 09 - Painting and Coating: Product requirements for painting for placement by this section.
   6. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
   7. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
   8. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
   9. Division 26 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   1. ARI 495 - Refrigerant Liquid Receivers.
   2. ARI 710 - Liquid-Line Driers.
   3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
   4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
   5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:
   1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
   3. ASME B31.5 - Refrigeration Piping.
   4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. ASTM International:
   1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
   3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
   4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
   6. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.

E. American Welding Society:
   1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
   2. AWS D1.1 - Structural Welding Code - Steel.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:
   1. UL 429 - Electrically Operated Valves.

1.03 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.5.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories.
   2. Hangers and Supports: Submit manufacturers catalog information including load capacity.

C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of refrigerant leak test.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

B. Perform Work in accordance with applicable] code and authority having jurisdiction for welding hanger and support attachments to building structure.

C. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.08 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Division 01 - Administrative Requirements: Requirements for coordination.

1.13 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, Type ACR hard drawn or annealed.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.02 UNIONS, FLANGES, AND COUPLINGS

A. 2 inches and Smaller:
   1. Ferrous Piping: 150 psig malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.03 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with ASME B31.5.

B. Support horizontal piping hangers as scheduled.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

H. Provide copper plated hangers and supports for copper piping.

I. Prime coat exposed steel hangers and supports in accordance with Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

K. Install pipe hangers and supports in accordance with Section 23 05 29.

3.05 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

E. Install pipe identification in accordance with Section 23 05 53.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08.

H. Arrange refrigerant piping to return oil to compressor. Slope horizontal piping 0.40 percent in direction of flow.

I. Flood refrigerant piping system with nitrogen when brazing.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 09.

L. Install valves with stems upright or horizontal, not inverted.

M. Insulate piping refer to Section 23 07 00.

N. Fully charge completed system with refrigerant after testing.

O. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

P. Install refrigerant piping in accordance with ASME B31.5.

3.06 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test refrigeration system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using electronic leak detector.

D. Repair leaks.

E. Retest until no leaks are detected.

3.07 SCHEDULES

A. Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	MINIMUM HANGER ROD DIAMETER COPPER TUBING Inches	MINIMUM HANGER ROD DIAMETER STEEL PIPE Inches
Up to 1/2	5	7	3/8	3/8

END OF SECTION

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. System cleaner.
2. Closed system treatment (water).
3. Condenser water system treatment.
4. Chemical feeder equipment including associated feeders, pumps, tanks, controls, meters and valves.
5. Test equipment.

B. Related Sections:

1. Section 26 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.02 REFERENCES

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.03 PERFORMANCE REQUIREMENTS

A. Provide system to treat water available at project site to maintain the safe and effective operation of the condenser water, chilled water and heating hot water systems.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

C. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout products.

B. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

C. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with applicable codes and standard for addition of non-potable chemicals to building systems and for discharge to public sewers.

B. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, with water analysis laboratories and full time service personnel.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.08 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for pumps, valves and water meters.

1.11 MAINTENANCE SERVICE

A. Division 01 - Execution and Closeout Requirements: Maintenance service.

B. Furnish monthly technical service visits, for one years starting at Date of Substantial Completion, to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements and corrective actions needed. Submit two copies of field service report after each visit.

C. Furnish laboratory and technical assistance services during this maintenance period.

D. Furnish on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.12 MAINTENANCE MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.01 SYSTEM CLEANER

A. Manufacturers:

1. Nalco.

B. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tri-Poly phosphate and sodium molybdate.

C. Biocide; chlorine release agents including sodium hypochlorite or calcium hypochlorite, or microbiocides including quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

2.02 CLOSED SYSTEM TREATMENT (WATER)

A. Manufacturers:

1. Nalco.

B. Sequestering agent to reduce deposits and adjust pH.

C. Corrosion inhibitors liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulfites.

D. Conductivity enhancers; phosphates or phosphonates.

2.03 CONDENSER WATER SYSTEM TREATMENT (COOLING TOWERS)

A. Manufacturers:

1. Nalco.

B. Sequestering agent to inhibit scaling; phosphonates, sodium polyphosphates, lignin derivatives, synthetic polymer polyelectrolytes, or organite phosphates.

C. Acid to reduce alkalinity and pH.

D. Corrosion inhibitor; zinc-phosphate, phosphonate-phosphate, phosphonate-molybdate and phosphonate-silicate, sodium totyltriazole, or low molecular weight polymers.

E. Biocide; chlorine release agents including sodium hypochlorite or calcium hypochlorite, or microbiocides including quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

2.04 BY-PASS (POT) FEEDER

A. Manufacturers:

1. Nalco.

B. Four quart quick opening cap for working pressure of 175 psig.

2.05 DRIP FEEDER

A. Manufacturers:

1. Nalco.

B. Plastic reservoir with coil of capillary tubing with probe, weights, charging syringe, and clip.

2.06 SOLUTION METERING PUMP

A. Manufacturers:

1. Nalco.

B. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous duty fully enclosed electric motor and drive, and built-in relief valve.

C. Electrical Characteristics:

1. 120 volts, single phase, 60 Hz.
2. Cord and Plug: Furnish unit with sufficient foot cord and plug for connection to electric wiring system including grounding connector.

2.07 SOLUTION TANKS

A. Manufacturers:

1. Nalco.

B. 30 gallon capacity, polyethylene, self-supporting, one gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.

2.08 AGITATOR

A. Manufacturers:

1. Nalco.

B. Weather-proof electric motor, stainless steel clamp and motor mount, with Type 316 stainless steel propeller.

C. Electrical Characteristics:

1. 120 volts, single phase, 60 Hz.
2. Cord and Plug: Furnish unit with sufficient length cord and plug for connection to electric wiring system including grounding connector.

2.09 LIQUID LEVEL SWITCH

A. Manufacturers:

1. Nalco.

B. Polypropylene housing with integrally mounted PVC air trap, receptacles for connection to metering pump, and low level alarm.

C. Electrical Characteristics:

1. 120 volts, single phase, 60 Hz.

2.10 CONDUCTIVITY CONTROLLER

A. Manufacturers:

1. Nalco.

B. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit and EMS system.

C. Electrical Characteristics:

1. 120 volts, single phase, 60 Hz.

2.11 WATER METER

A. Manufacturers:

1. Nalco.

B. Displacement type cold-water meter with sealed, tamper-proof magnetic drive, impulse contact register, single-pole, double-throw, dry contact switch.

C. Electrical Characteristics:

1. 120 volts, single phase, 60 Hz.

2.12 SOLENOID VALVES

A. Manufacturers:

1. Nalco.

B. Forged brass body globe pattern, normally open or closed as required, weatherproof solenoid enclosure, and continuous duty coil.

C. Electrical Characteristics: 120 volts, single phase, 60 Hz.

2.13 TEST EQUIPMENT

A. Furnish white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titration burettes and associated reagents.

B. Furnish following test kits:

1. Alkalinity titration test kit.
2. Chloride titration test kit.
3. Sulphite titration test kit.
4. Total hardness titration test kit.
5. Low phosphate test kit.
6. Conductivity bridge, range 0 - 10,000 micro-ohms.
7. Creosol red pH slide, complete with reagent.
8. Portable electronic conductivity meter.
9. High nitrite test kit.

PART 3 EXECUTION

3.01 PREPARATION

A. Operate, fill, start and vent systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

3.02 CLEANING

A. Concentration:

1. As recommended by manufacturer.
2. One pound per 100 gallons of water contained in the system.
3. One pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.

B. Hot Water Heating Systems:

1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of Architect/Engineer.

D. Flush open systems with clean water for one hour minimum. Drain completely and refill.

E. Remove, clean, and replace strainer screens.

F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

A. Install Work in accordance with approved submittal drawings.

3.04 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and interconnecting piping. Install around balancing valve downstream of circulating pumps.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Install 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.05 CONDENSER WATER SYSTEMS (COOLING TOWERS)

A. Provide automatic condenser water control systems for inhibitor feed, blow-down, and biocide feeds.

1. Provide meter activated inhibitor application.
2. Provide conductivity activated blow-down.
3. Provide meter fed biocide with blow-down locked out to ensure biocide retention time.

B. Incorporate solid state integrated circuits and digital LED displays, in NEMA 250 Type 12 steel enclosure. Provide lockable door with gaskets.

C. Base dissolved solids control on conductivity and include:

1. LED digital readout display (micro-ohm/cm).
2. Temperature compensated sensor probe adaptable to sample stream manifold.
3. High, low, normal conductance indicator lights (LED).
4. High or low conductance alarm light (flash or steady switch), trip points field adjustable. Furnish flash or steady switch with silence position.
5. Illuminated legend indicating "ALARM" whenever alarm condition exists.
6. Hand-off-automatic switch for solenoid bleed valve.
7. Illuminated legend indicating "BLEED" when valve is operated.
8. Adjustable hysteresis or dead-band (internal).

D. Base inhibitor feed control on make-up volume and include:

1. Solid state counter (1-15 field selectable).
2. Solid state timer (adjustable 1/4 to 5 minutes).
3. Test switch.
4. Hand-off-automatic switch for chemical pump.
5. Illuminated legend indicating "FEED" when pump is activated.
6. Solid state lockout timer (adjustable 1/4 to 3 hours) and indicator light. Lockout timer to deactivate pump and activate alarm circuits.
7. Panel total (quantity of makeup), Electro-mechanical type.

E. Biocide programmer to include:

1. 24-hour timer with 14 day skip feature.
2. Precision solid state bleed lockout timer (0-9 hours) and biocide pump timer (0 - 2-1/4 hours), clock controlled.
3. Solid state alternator to enable use of two different formulations.
4. Digital display of time of day (24 hours).
5. LED display of day of week (14 days).
6. Fast and slow clock set controls (internal).
7. Battery back-up so clock is not disturbed by power outages, quartz timekeeping accuracy.
8. Hand-off-automatic switches for biocide pumps.
9. Illuminated legend indicating "BIOCIDE A" or "BIOCIDE B" when pump is activated.

F. Provide water meter on system make-up, wired to control system.

G. Provide solution pumps to feed sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Provide agitator in accordance with treatment suppliers recommendations.

H. Provide conductivity controller to sample condenser water and operate solenoid bleed valve and piping to blow-down controller. Wire sampler to open when condenser water pump is operating.

I. Introduce biocide to tower by intermittent slug feed, continuous feed with solution pump or solenoid valve on tank (chlorine).

J. Provide liquid level switch in each solution tank to de-activate solution pump and agitator, and sound local alarm , and notify EMS.

K. Install 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.06 DEMONSTRATION

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Furnish eight hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

END OF SECTION

SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Duct Materials.
2. Insulated flexible ducts.
3. Single wall spiral round ducts.
4. Underground ductwork.
5. Transverse duct connection system.
6. Casings.
7. Ductwork fabrication.
8. Duct cleaning.

B. Related Sections:

1. Division 03 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 09 - Painting and Coating: Execution requirements for Weld priming, weather resistant, paint or coating specified by this section.
3. Division 11 - Foodservice Equipment: Product requirements for kitchen range hoods for placement by this section.
4. Division 23 05 29 - Hangers and Supports for HVAC and Plumbing Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
5. Division 23 33 00- Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.02 REFERENCES

A. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
4. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
9. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.

10. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
12. EPDM (ethylene propylene diene M-class rubber) Gas use Standard Specification:
    a. ASTM D2000 Standard Specification Thermal Properties
    b. ASTM D2000 Standard Specification Maximum Service Temperature, Air
    c. ASTM D394 Standard Specification Abrasion resistance
    d. ASTM D624 Standard Specification Tensile Strength

13. High Density Polyethylene – HDPE:
    a. ASTM D1238 Standard Specification Melt Index
    b. ASTM D1505 Standard Specification Density
    c. ASTM D638 Standard Specification Tensile Strength
    d. ASTM D790 Standard Specification Flexural Modulus
    e. ASTM D746 Standard Specification Brittleness Temperature
    f. ASTM D1693 Standard Specification Environmental Stress Crack Resistance

14. AIRTITE SEALANT block co-polymer adhesive sealant:
    a. ASTM D412 Ultimate Tensile Strength
    b. ASTM D1002 Shear Strength
    c. ASTM D3807 Cleavage Peel Resistance
    d. ASTM D2240 Durometer Hardness

15. MACSEAL butyl rubber gasket (1/4" tape):
    a. E84-01 Standard Test Method for Surface Burning Characteristics of Building

B. California Mechanical Code:

1. CMC – State of California Mechanical Code.

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Air Duct Leakage Test Manual.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 181 - Factory-Made Air Ducts and Connectors.

F. American Architectural Manufacturers Association (AAMA):

1. MAXSEAL butyl rubber gasket (1/4" tape)
   804.1-85..... Pass Standard Test Method (Technical Summary Section 3.2)

1.03 PERFORMANCE REQUIREMENTS

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts, if it is not shown on the drawings.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire rated and other walls.
7. Fan coil unit installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
9. Equipment service clearance, access panels and door swings.

C. Product Data: Submit data for duct materials, duct liner and duct connectors.

D. Test Reports: Indicate pressure tests performed. Include date; section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

E. Acceptance or no exceptions taken by the engineer on any substitution proposed by the contractor shall not be construed as relieving the contractor from compliance with the project's specifications and performance requirements nor departure there from. The contractor remains responsible for details and accuracy for confirming and correlating quantities and dimensions and for the selection of fabrication processes, techniques and assembly, coordination of his work with that of all other trades and making any needed modifications consequent to the substitution at his own cost and for performing the work in a safe manner.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A standards.

C. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.08 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum three weeks prior to commencing work of this section.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements.

B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 DUCT MATERIALS

A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.

B. Fasteners: Rivets, bolts, or sheet metal screws.

C. Steel shapes shall be hot rolled, galvanized.

D. Screws and bolts shall be cadmium plated.

E. Materials and fabrication shall comply with 1994 Uniform Mechanical Code Chapter 6.

F. For supply air and return air ductwork above roof, or exposed to weather, use double walled duct with insulation in-between . Size of duct indicated on the drawings shall be internal dimension. Internal and external duct shall be of same gauge.

G. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.02 INSULATED FLEXIBLE DUCTS

A. Manufacturers:

1. Casco
2. Thermflex
3. Glen Flex
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Flexible duct shall consist of an exterior reinforced laminated vapor barrier, 1-1/2 inch thick fiberglass insulation (K = .25 @ 75 degrees F), 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. Flexible fiberglass duct shall meet the requirements of NFPA No. 90A and UL 181.

1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -10 degrees F to 160 degrees F.
4. Furnish each flexible duct section with integral clamping devices for connection to round or oval fittings.
5. Join each flexible duct section to main trunk duct through sheet metal fittings. Construct fittings of galvanized steel and equip with factory installed volume damper having positive locking regulator. Provide fittings installed in lined ductwork with insulation guard.
6. Flexible ducts shall be supported at or near mid-length with 2 inch wide, 28 gage steel hanger collar, attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets. The maximum length connecting to terminal outlets shall be 7 feet and minimum length of 5 feet.
7. Insulated flexible ducts shall be continuous, single pieces, 7' in length for low pressure, and they shall be adequately supported with a center strap support. Ducts shall be installed with a minimum radius of bend of two duct diameters. These flexible ducts are specified to tie into side inlet/outlet insulated ceiling diffusers or return air grills. The metal duct system shall be installed such that sufficient room exists to accommodate the flex duct straight runs from the metal duct to the ceiling devices. Distances too close to meet the intent of the specifications will be revised and installed according to the specifications.
8. Low pressure ductwork shall have precut lengths with continuous inner liner, factory installed female collars and fastening devices at each end, a factory installed manual balancing damper assembly complete with a level position indicator and a positive locking device.
9. Provide all round duct takeoffs from low pressure ducts with aluminum draw band, or Spin-In Twist-Lok fittings, approved for installation in return air plenum.

C. UL Requirements:

1. The entire flexible duct assembly shall be labeled in accordance with UL-181 Class I air duct requirements and not have a flame and smoke spread rating in excess of 25/50.
2. Installation must conform with factory supplied and UL approved print installation instruction sheets.
3. Submittals will be required to include product data sheets and installation instruction sheets in order to assure awareness of the proper installation technique.

2.03 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers:

1. McGill Airflow Corporation
2. Semco Incorporated
3. Tangent Air Corp
4. Spiral Mfg. Co., Inc.
5. Substitutions: Division 01 - Product Requirements.

B. Product Description: UL 181, Class 1, round spiral lock seam duct constructed of galvanized steel.

C. Construct duct with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	26
15 inches to 26 inches	24
28 inches to 36 inches	22
38 inches to 50 inches	20
52 inches to 84 inches	18

D. Construct fittings with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	24
15 inches to 26 inches	22
28 inches to 36 inches	20
38 inches to 50 inches	20
52 inches to 60 inches	18
62 inches to 84 inches	16

2.04 CASINGS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.

B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection. Furnish clear wire glass observation ports, minimum 6 x 6 inch size.

C. Fabricate acoustic casings with reinforcing turned inward. Furnish 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb. /cu ft minimum glass fiber media, on inverted channels of 16 gage.

2.05 RECTANGULAR DUCT FABRICATION (GENERAL)

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals except as modified by this specification.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Elbows shall be radius or short radius with vanes, type RE 1 and RE 3 in the SMACNA manual. Mitered elbows with turning vanes and other types shall not be used. Construct vanes per pages A.41 and A.43 of the SMACNA manual.

C. Divided flow branches shall be per SMACNA manual figure 2-5, type 1 or type 4A or 4B only.

D. Branch connections per SMACNA manual figure 2-6; 45-degree entry shall only be used where airflow in branch is less than 25% of total airflow in main duct.

E. Offsets shall be SMACNA manual figure 2-7, type 3 only.

F. Bell-mouth transitions shall be used on connections to air handling units and plenums.

G. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:
   a. TDC.
   b. Ductmate Industries, Inc.
   c. Nexus Inc.

H. Longitudinal Seams: Pittsburgh lock sealed with non-curing polymer sealant. Button punch snap lock seams are not acceptable to the University and shall not be used.

I. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations.

J. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sf of non-braced panel area unless ducts are lined.

2.06 RECTANGULAR DUCTWORK FABRICATION (INTERIOR)

A. Low Pressure Duct Construction Schedule: (2 inch" S.P. and below). Include all return, exhaust, supply branches and ductwork downstream of terminal units.

Duct Dimension (Inches)	Material Gauges	Construction of Transverse Joints, Bracing and Reinforcing
0 to 12	26	Hemmed S slip spaced not more than 10' apart
13 to 30	24	Ductmate Jr.**, or 1" G lock spaced not more than 10' apart
31 to 42	22	Ductmate Jr.**, spaced not more than 5' apart
43 to 54	22	Ductmate**, spaced not more than 4' apart
55 to 60	20	Ductmate**, spaced not more than 4' apart
61 to 84	20	Ductmate**, spaced not more than 4' apart
85 and up	18	Ductmate**, spaced not more than 4' apart. Provide intermediate bracing for low pressure ductwork 85" and larger

Note: * Based on maximum of 2.0" WG.
** The Lockformer Company TDC or approved equal

1. Provide intermediate bracing for low pressure ductwork 85 inches and larger.
2. All ducts over 18 inches in either dimension shall be stiffened with beads on 24 through 20 gage. Cross break on 18 and 16 gauge. Longitudinal seams shall be Pittsburgh locks Snap-Lock shall be limited to 12 inch maximum width of ducts.

B. Strap hanger shall be a minimum of 1 inch, #18 gauge galvanized steel attached to the bottom of ducts at 8'- 0" OC and as required by CMC/UMC and SMACNA guidelines.

C. Elbows shall be radius or short radius with vanes, type RE 1 and RE 3 in the SMACNA manual. Mitered elbows with turning vanes and other types shall not be used. Construct vanes per pages A.41 and A.43 of the SMACNA manual.

D. Divided flow branches shall be per SMACNA manual figure 2-5, type 1 or type 4A or 4B only.

E. Branch connections per SMACNA manual figure 2-6; 45-degree entry shall only be used where airflow in branch is less than 25% of total airflow in main duct.

F. Offsets shall be SMACNA manual figure 2-7, type 3 only.

G. Bellmouth transitions shall be used on connections to air handling units and plenums.

H. Provide Ductmate and Ductmate, Jr. with all required material including metal cleats, corner bolts and nuts, angles, clips and gaskets, all installed in accordance with manufacturer's recommendations and supervision.

I. Quadrant volume damper blades in fittings shall be two gauges heavier than the fittings.

J. Longitudinal Seams: Pittsburgh lock sealed with non-curing polymer sealant. Button punch snap lock seams are not acceptable and shall not be used.

K. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations.

L. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of non-braced panel area unless ducts are lined.

M. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

N. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

2.07 RECTANGULAR DUCTWORK FABRICATION (EXTERIOR)

A. Provide duct and fittings with exceptional noise and thermal control in air handling systems. This double-wall, insulated ductwork shall be constructed of a solid steel outer pressure shell and a steel inner liner with a layer of insulation sandwiched between. Other insulation materials and rectangular duct and fittings shall be shipped fully assembled with transverse duct connector flanged ends. Both outer pressure shell and metal inner liner shall incorporate Pittsburgh lockseam construction and TDC end connectors. Ductwork is fully assembled with a finished length of 56-1/4 inches or 68-1/4 inches. Refer to 2.06 for duct gauge requirements.

2.08 ROUND DUCT AND FITTING FABRICATION (INTERIOR)

A. Circular (across section) ducts shall be galvanized steel of spiral seam construction, fittings shall have continuous, welded, stamped construction both manufactured by United Sheet Metal, Omniduct, Spiromatic, Spiro Duct, Casco or approved equal.

B. Make joints between two ducts with beaded sleeve joint, with duct sealer applied to both the male and female duct ends, then mechanically fastened with sheet metal screws.

C. Install all duct work according to the following: the radius of elbows shall be minimum of 1 1/2 times diameter or maximum width of duct. Gored ells are not acceptable. Violations of this requirement shall be removed from the system and replaced per the design documents and the drawings at no cost to the Owner. Failure to do so will result in the Project Manager replacing the defective installation and back charging the cost to the offending contractor.

D. Tee fittings shall be of conical type changing in shape from round to rectangular with transformation joint with minimum of 1 to 7 taper.

E. Corrugated or flexible metal duct, or shop fabricated circular ducts will not be acceptable.

2.09 ROUND DUCT AND FITTING FABRICATION (EXTERIOR)

A. Provide double-wall, insulated duct and fittings with exceptional noise and thermal control in air handling systems. They shall be constructed of a solid galvanized sheet metal outer pressure shell and a solid galvanized sheet metal inner liner with a layer of 2" insulation sandwiched. The shell constructions shall have longitudinal seam. Refer to 2.03 for duct gauge requirements.

2.10 UNDERGROUND DUCTWORK

A. High-density polyethylene (HDPE) plastic ductwork. All fittings, boots, and duct section connectors shall be constructed of polyethylene.

B. All joints shall be gasket and sealed with screws or clamps per manufactures instructions.

C. All underground duct shall be installed in accordance with the requirements of the State Building Code.

1. Saddles shall be cured in outside air and not permitted in otherwise publicly within the first two hours in occupied spaces.
2. No piping grounding needed.
3. Shop drawings are required for underground air ducts.

D. Ductwork installations shall be pressure tested prior to connection to fans and prior to knockouts for final connections and after allowing 24 hours for sealing joint sealants to cure.

E. All tests should be done according to factory testing procedures.

F. Knockouts for final connections recommend to be completed after sign-off by Commissioning Authority.

2.11 DUCT SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

C. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 181 listed; passes UL 723 for flame spread and smoke development; and complying with NFPA requirements for Class 1 ducts.

D. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

E. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

F. Provide sealant or tape for metal ducts at duct joints which are defined as transverse joints between duct sections including girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections, access doors and frames, and abutments to building structure. Also provide the same at duct seams which are defined as longitudinal joint between duct sections. Spiral lock seams in factory fabricated round or oval ducts are excluded.

G. Sealant for low-pressure ducts shall be: Design Polymerics- DP1010 or 1020, Childers Chil-Flex CP145A/146, Foster's Duct-Fas 32-19, Kingco-Glenkote11-500, Ductmate ProSeal or FiberSeal, or equal. Provide tape joints with canvas fastened with Borden Chemical Division Arabol adhesive, or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify sizes of equipment connections before fabricating transitions.

3.02 INSTALLATION

A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, as required in this section and in the Contract Drawings.

B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Use beaded sleeve couplings for joining round duct and flexible ducts.

D. Install duct hangers and supports in accordance with Section 23 05 29.

E. Use double nuts and lock washers on threaded rod supports.

F. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.

G. Casings: Install floor mounted casings on 4 inch high concrete curbs. Refer to Division 03. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, furnish liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

3.03 INSTALLATION OF METAL DUCTWORK

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (5% leakage for systems rated 3 inch and under; 1% for systems rated over 3 inch) and noiseless (no objectionable noise) systems capable of performing each indicated service. Install each run with a minimum number 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. Support vertical ducts at every floor.

B. Field Fabrication: Complete fabrication of work at project as necessary to match shop fabricated work and accommodate installation requirements.

C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, column, and other structural and permanent enclosure elements of building. Limit clearance to 1/2 inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1 inch clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

D. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

E. Tape the clips, Snaplock seams and joints or connections of the metal supply, return and exhaust ducts and the grilled and diffuser connections with 4 inch strips of 6 oz. canvas attached with Arabol or Hardcast adhesive. Tape the filter frames the same as ducts. Coat all canvas exposed to the weather with Tuff Bond #12. Taping of Pittsburgh seams is required. Exposed interior ductwork intended for open ceilings shall not be taped or covered with canvas.

F. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

G. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

H. Round ducts shall be used to the maximum extent possible. As duct size increases, flat oval shall be considered. Rectangular ducts shall be limited to areas of space restriction with a maximum aspect ratio of 2:1. If due to a structural clearance constraint, duct aspect ratio can be increased and/or duct cross section reduced if upstream transition has included angles of 60 degrees or less and downstream transition has included angles of 30 degrees or less.

I. Ducts exposed outside to elements shall only be of round construction to shed rainwater. If conditions do not allow round ducts, provisions shall be provided to slope the flat top of rectangular ductwork so rainwater will not stand on top of duct.

J. Except for connection of terminal discharge duct to air outlets, 90 degree taps shall not be used unless space prohibits the use of low loss fittings. Takeoff feeding terminals shall be conical branch; 45 wye, conical branch; low loss tee; bell mouth, or branch with a loss coefficient equivalent to that for the conical branch. The slopes of transitions shall be approximately one to five, and no abrupt changes or offsets of any kind in the duct system shall be permitted.

K. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.

L. Install ducts with fewest possible joints.

M. Install fabricated fittings for changes in directions, size, and shape and for connections.

N. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

O. Install ducts vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs in ducts that would be over 12 feet in length.

P. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

Q. Install ducts with a clearance of 2 inch on each side, plus allowance for insulation thickness.

R. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

S. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

T. Seal all joints and seams. If specification requires duct pressure test then duct sealant can be used instead of canvas and Arabol. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

U. Install heavy volume dampers at all main supply, return and exhaust duct branch connections or as indicated on the drawings. Heavy volume dampers shall be Pottorff Series 400 AF with handle, or approved equal.

V. Duct hangers shall be attached to horizontal slabs with steel angle clips secured with inserts, strapped to vertical walls, bolted to beams and joists, as per SMACNA guidelines, or as approved by the Architect.

W. All ducts and equipment shall be blown out prior to operating.

X. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures and telephone equipment rooms.

Y. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

Z. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers or combination fire/smoke dampers, sleeves.

AA. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by California building codes.

BB. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

CC. Do not paint interiors of metal ducts.

DD. Protect duct openings from damage and prevent entrance of foreign materials.

3.04 INSTALLATION OF FLEXIBLE DUCTS

A. Maximum length: For any duct run using flexible ductwork, do not exceed 7'- 0" extended length.

B. Installation: Install in accordance with Section III of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible", latest edition.

C. Bends in flexible ducts shall have a radius of not less than 1.5 times the internal diameters.

3.05 INSTALLATION OF UNDERGROUND DUCTS

A. To ensure an air and water tight system, carefully adhere to the manufacturer's installation instructions. HDPE manufactured by "A.K. Duct" requires AIRTITE sealant caulk which must be used as directed.

B. After the excavation has been made, ductwork shall be set in sand or light aggregate. Pea gravel or sand shall be used to backfill. Spread the backfill material evenly around the duct making sure there are no gaps. Tamping in place is a recommended practice. AKDUCT will not "float" when backfilled to within 2" to the top of the duct. Concrete can then be poured per construction documents.

CAUTION:

When backfilling or grading, care should be taken to not push heavy loads directly on the duct, nor should heavy equipment be allowed to run over the duct.

C. Provide manufacturer's seal wrap when connecting pipe and fittings. Align and secure damp to gasket per manufacturer's recommendations.

D. Slope all ductwork 1/8" per foot back to main plenum at ground penetration. If water is suspected, drill a hole in the side of the protruding Plenum, (8" above the concrete) and use a shop-vac to remove any water. You can then place a rubber plumbing test plug in the hole according to the size drilled.

3.06 EQUIPMENT CONNECTIONS

A. General: Connect metal ductwork to equipment as indicated. Provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotary machinery. Provide access doors as indicated.

3.07 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load. Wire and friction clamps shall not be used.

D. Install concrete inserts before placing concrete.

E. Install drilled in concrete anchors after concrete is placed and completely cured.

F. Do not use powder-actuated concrete fasteners.

3.08 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install Pitot tube openings for testing of systems. Install Pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

B. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 to 7 feet maximum length of flexible duct held in place with strap or clamp except as otherwise shown on the drawings. Do not use flexible duct on moisture laden air systems.

C. Connect air terminal units to supply ducts directly with at least one duct size larger than air terminal connection, except as shown otherwise on the drawings.

3.09 CLEANING NEW SYSTEM

A. Division 01 - Execution and Closeout Requirements: Final cleaning.

B. If the ductwork system is maintained in a clean state during the installation the following is not required. If in the opinion of the Architect/Engineer or Owner's Representative the ductwork system is dirty the following shall be complied with.

C. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

D. Use service openings, as required, for physical and mechanical entry and for inspection.

E. Create other openings to comply with duct standards.

F. Disconnect flexible ducts as needed for cleaning and inspection.

G. Remove and reinstall ceiling sections to gain access during the cleaning process.

H. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

I. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

J. Cleaning Requirements:

1. Interior surfaces of all supply ductwork shall be cleaned of dust and dirt at the fabrication shop during fabrication.
2. Supply Ductwork shall be sealed to protect interior surfaces prior to being shipped and handled.
3. Seals and wrapping shall be removed on job site at time of installation.
4. Seal open duct ends during at the end of each day.

K. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

L. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and re-inspect ducts.

3.10 SCHEDULES

A. Static-Pressure Classes: Construct ducts according to the following:

1. Supply Ducts (Interior/Exterior and Underground Installation): 4-inch wg.
2. Supply Ducts (In Mechanical Equipment Rooms): 4-inch wg.
3. Return Ducts (Negative Pressure): 2-inch wg.
4. General Exhaust Ducts (Negative Pressure): 2-inch wg.
5. Vertical risers shall be constructed to a minimum of 4-inch wg, regardless of type.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Back-draft dampers.
2. Combination fire-and-smoke dampers.
3. Duct access doors.
4. Volume control dampers.
5. Flexible duct connections.
6. Duct test holes.

B. Related Sections:

1. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
2. Division 26 - Equipment Wiring Connections: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 92A - Recommended Practice for Smoke-Control Systems.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 555 - Standard for Safety for Fire Dampers.
2. UL 555C - Standard for Safety for Ceiling Dampers.
3. UL 555S - Standard for Safety for Smoke Dampers.

1.03 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.

C. Product Data: Submit data for shop fabricated assemblies and hardware used.

D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.

1. Fire dampers including locations and ratings.
2. Smoke dampers including locations and ratings.
3. Backdraft dampers.
4. Flexible duct connections.
5. Volume control dampers.
6. Duct access doors.
7. Duct test holes.

E. Product Data: For fire dampers, smoke dampers, combination fire and smoke dampers submit the following:

1. Include UL ratings, California Sate Fire Marshal approval and NFPA 90A, dynamic ratings, leakage, pressure drop and maximum pressure data.
2. Indicate materials, construction, dimensions, and installation details.
3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

F. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Acceptance or no exceptions taken by the engineer on any substitution proposed by the contractor shall not be construed as relieving the contractor from compliance with the project's specifications and performance requirements nor departure there from. The contractor remains responsible for details and accuracy for confirming and correlating quantities and dimensions and for the selection of fabrication processes, techniques and assembly, coordination of his work with that of all other trades and making any needed modifications consequent to the substitution at his own cost and for performing the work in a safe manner.

1.04 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of access doors, test holes and combination smoke/fire dampers.

C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.05 QUALITY ASSURANCE

A. Dampers tested, rated and labeled in accordance with the latest UL requirements.

B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

C. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum three weeks prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Protect dampers from damage to operating linkages and blades.

C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

D. Storage: Store materials in a dry area indoor, protected from damage.

E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Coordinate Work where appropriate with building control Work.

1.11 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

1.12 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.01 BACK-DRAFT DAMPERS

A. Manufacturers:

1. Pottorff

2. Ruskin
3. Greenheck

B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, extruded aluminum. Blades, maximum 6 inch width, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment counter balance weight to permit setting for varying differential static pressure. Back draft damper shall be capable of adjusting to 0.025 inches of water pressure.

2.02 COMBINATION FIRE AND SMOKE DAMPERS / FIRE DAMPERS

A. Manufacturers:

1. Pottorff
2. Ruskin

B. Furnish and install California State Fire Marshal approved combination smoke/fire dampers where shown on plans. The dampers shall meet all the requirements for smoke dampers per the latest edition of NFPA 90A and UL standards. Units shall be tested and listed under UL 555 and UL 555S. Rating 1-1/2 hours for installation in one or 2-hour partitions. The seals shall be non-degradable steel to steel. Leakage shall not exceed 15 cfm/sq. ft. at one inch w.g. and shall be tested at 850 degrees F. Fire releasing device

shall be UL 33 listed melting fusible links. Dampers shall be provided in sleeves with pre-mounted non-stall motor actuators and dual-position indicators for remote annunciation, if required. The complete assembly shall be factory cycled and tested prior to shipment. Provide suitable access for inspection and servicing of each damper.

2.03 DUCT ACCESS DOORS

A. Manufacturers:

1. Air Balance, Inc.
2. Duro Dyne Corp.
3. Register & Grille Mfg. Co., Inc.
4. Ruskin Mfg. Co.
5. Ventfabrics, Inc.
6. Zurn Industries, Inc.; Air Systems Div.

B. General:

1. Access doors shall be of size to permit duct cleaning, inspection and adjustment and replacement of fire damper links, fan bearings, etc. through access opening. The minimum size shall be 12" x 12" or equivalent size as approved by the engineer. Access door gauges shall match duct.
2. Fore square or rectangular ducts:
   a. Door shall be double wall type with felt or foam rubber gasket seal and shall have butt hinges and sash locks on 2-opposite sides, at a maximum spacing of 9". Use sash locks on both sides where hinged door swings may be obstructed.
   b. Door in insulated ducts shall be double walled and shall contain a full thickness of insulation between the door panels.

3. Access doors for circular ducts shall be United Sheet Metal Type AR-W, Omniduct, Spiromatic, Spiro-Duct, or approved equal. Door shall have same requirements as for rectangular duct.

C. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

2.04 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Ventfabrics, Inc.
2. Young Regulator Co.
3. Duro Dyne Corp.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axle's full length of damper blades and bearings at both ends of operating shaft.

C. Dampers installed in ductwork, in furred ceiling spaces or in roof spaces with less than 30" of clearance below beams, joints or other construction, and where access panels are not provided shall have damper rods extended below ceiling and terminated with a concealed damper regulator, Ventlok, Young, or approved equal. The location of each damper shall be identified by a Green dot for supply air registers and a red dot for return air grills. The one inch diameter dots shall be placed by the HVAC contractor on tee tee bar ceiling gird nearest the damper and stuck on the damper side of the tee with one half of the dot showing and the other half of the dot folded up around the top part of the tee bar.

D. Damper blades shall not exceed 10" in width and shall be a minimum of 16-gauge galvanized steel, or Re-gauge aluminum. All dampers shall be frame mounted. The damper frame shall be of minimum 12-gauge steel channel. Except that dampers less than 18" maximum size may have 16-gauge by 1-1/4" minimum flat bar stock frames. Multi blade dampers shall be arranged for opposed blade operation.

E. Steel parts shall be galvanized or factory-finished with a metal primer and enameled finish and all cut edges shall be coated as described above. All parts of dampers in outside air intakes shall be galvanized. Bearings shall be precision sleeve type of oil-impregnated bronze, Teflon or Nylon.

F. Provide locking and indicating quadrants installed in accessible locations. For wrapped ducts, quadrants shall be bracket mounted with a recessed flange.

G. Where dampers are inaccessible for adjustments, provide Ventfabrics No. 666,or equal by Young Regulator Co.; with remote operator.

H. All dampers shall be shipped with factory attached 18" long orange ribbon attached to operator shaft.

2.05 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

1. Duro Dyne Corp.
2. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick (24 ga), galvanized sheet steel or 0.032-inch-thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz. /sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lb/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.06 SCREENS

A. Screens shall be 1 inch mesh, 12 gauge stainless steel wire set in 1 inch galvanized channel frames for all openings.

2.07 DUCT HARDWARE

A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

1. Test holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
2. Quadrant locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12 inch. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

B. Manufacturer: Subject to compliance with requirements, provided duct hardware of one of the following:

1. Ventfabrics, Inc.
2. Young Regulator Co.
3. Duro Dyne

2.08 TURNING VANES

A. Square throat elbow with vanes not allowed. Provide short radius elbows with vanes per SMACNA details as indicated on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify rated walls are ready for fire damper installation.

C. Verify ducts and equipment installation is ready for accessories.

D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.02 INSTALLATION.

A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide a volume control for each grille and diffuser and in all other locations necessary to properly balance the system.

C. Quadrants on insulated ducts shall be mounted on sheet metal brackets, set flush with the insulation.

D. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings. Back draft dampers are not required for the fans with continuous operation and kitchen exhaust fans.

E. Provide and install access doors at convenient and individual locations in ducts where fire, smoke or automatic dampers, fan bearings, filters, humidifiers or other equipment is installed in ducts.

F. Provide and deliver to the appropriate trade for installation where you direct, access doors or panels in building construction for access to duct doors or panels, damper quadrants, control devices, or other devices requiring access.

G. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access. Review locations prior to fabrication.

H. Install the following sizes for duct-mounting, round access doors:

1. 8 inches in diameter for up to 12-inch diameter duct size.
2. 12 inches in diameter for 13-inch to 19 inch duct sizes.
3. 18 inches in diameter for 20-inch to 25 inch duct sizes.
4. 24 inches in diameter for larger duct sizes than listed above.

I. Label access doors according to Division 23.

J. Install temporary duct test holes required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

K. Install fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
2. Install dampers square and free from racking with blades running horizontally.

3. Do not compress or stretch damper frame into duct or opening.
4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. For fans developing static pressures of 5 inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect flexible ducts to metal ducts with adhesive and draw bands.

O. Provide instrument test holes in ductwork at fan inlets and outlets and elsewhere as required by Testing, Adjusting and Balancing Contractor for testing and balancing purposes.

3.03 DEMONSTRATION

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate re-setting of fire dampers and combination fire/smoke dampers to Owner's representative.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Power Ventilators.
2. Prefabricated roof curb.
3. Inline ceiling fans.
4. Duct blowers or cabinet fans.

B. Related Sections:

1. Division 23 07 00 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
2. Division 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
3. Division 23 33 00- Air Duct Accessories: Product requirements for duct accessories for placement by this section.
4. Division 26 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.02 REFERENCES

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:

1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Refrigeration Institute:

1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. Underwriters Laboratories Inc.:

1. UL 705 - Power Ventilators.

1.03 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Acceptance or no exceptions taken by the engineer on any substitution proposed by the contractor shall not be construed as relieving the contractor from compliance with the project's specifications and performance requirements nor departure there from. The contractor remains responsible for details and accuracy for confirming and correlating quantities and dimensions and for the selection of fabrication processes, techniques and assembly, coordination of his work with that of all other trades and making any needed modifications consequent to the substitution at his own cost and for performing the work in a safe manner.

1.04 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

D. Balance Quality: Conform to AMCA 204.

E. Energy Recovery Unit Wheel Energy Transfer Rating: Meet ARI 1060.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

1.11 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of belts for each fan.

PART 2 PRODUCTS

2.01 POWER VENTILATORS

A. Manufacturer:

1. Loren Cook
2. Greenheck
3. ACME

B. General: Except as otherwise indicated, provide standard prefabricated power ventilator units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.

C. Centrifugal Roof Ventilators: Provide centrifugal roof type, curb mounted, power ventilators of type, size, and capacity as scheduled, and as specified herein.

1. Type: Centrifugal fan, direct or belt driven as scheduled. Provide aluminum, weatherproof housings, low silhouette, statically and dynamically balanced, UL labeled and certified by AMCA. Provide square base to suit roof curb. Provide permanently lubricated type motor.
2. Housing Design: Hooded low contour type.
3. Provide high efficiency type motor. The motor and drive assembly shall be located out of the exhaust air system supported by a rugged galvanized steel frame. Motors shall be factory wired and installed with safety switches.

4. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection. Motors shall have neoprene vibration isolator
5. Bird Screens: Provide removable bird screens, 1/2" mesh, 16-gage aluminum or brass wire.
6. Provide fabricated roof curb with integral backdraft dampers.

2.02 PREFABRICATED ROOF CURBS

A. Available Manufacturers: Subject to compliance with requirements, roof curbs that may be incorporated in the work shall be of same manufacture as fan.

B. General: Provide manufacturer's standard shop-fabricated units modified if necessary to comply with requirements.

C. Gage and Height: Fabricate units of metal gage and to height above roof surface as indicated. Where gage or height are not indicated, fabricate units of 14 gage metal, and nominal height of 14 inch. Provide treated wood nailer, not less than 1-5/8 inch thick and of width indicated, but not less than width of support wall assembly. Anchor nailer securely to top of metal frame unit. Provide lumber pressure treated with water-borne preservatives for "above ground" use, complying with AWPB LP-2.

D. Insulate units inside structural support wall with rigid glass fiber insulation board of approximately 3 pound density and 1-1/2 inch minimum thickness, except as otherwise indicated.

2.03 INLINE FANS

A. Manufacturers:

1. Loren Cook
2. Greenheck
3. Penn

B. Fan shall be duct mounted, belt driven centrifugal cabinet fan with external motor mount.

C. Fan shall bear the AMCA certified ratings seal for sound and air performance.

D. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with two access doors and integral duct collars. Internal blower assembly shall be mounted on rubber vibration isolators. Motor shall be out of the air stream. Hanging brackets shall be provided for horizontal installation. Unit shall bear an engraved aluminum nameplate.

E. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum. Wheel shall be balanced in accordance with AMCA Standard 204-96.

F. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage and phase.

G. Bearings shall be permanently lubricated, sealed ball type selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

H. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

2.04 CEILING FANS

A. Manufacturers:

1. Greenheck
2. Loren Cook
3. Penn

B. Centrifugal Fan Unit: Direct driven with injection molded resin, galvanized steel housing, resilient mounted motor, gravity backdraft damper in discharge opening, integral outlet duct collar. Discharge position convertible by moving interchangeable panels.

C. Disconnect Switch: Fan mounted toggle switch for thermal overload protected motor.

D. Grille: Injection molded white plastic.

E. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.

F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection.

G. Accessories:

1. Wall cap with damper, round duct rectangular duct (as shown on drawings) inlet.
2. Roof cap with roof curb.
3. Fan speed controller.

H. Performance:

1. Air Flow: As per drawings.
2. Static Pressure: As per drawings.
3. Fan RPM: As per drawings.
4. Sones: As per drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.02 PREPARATION

A. Furnish roof curbs to roofing contractor for installation.

3.03 INSTALLATION

A. Secure fans and gravity ventilators with stainless steel lag screws to roof curb or anchor the unit ash shown on the drawings.

B. Fans: Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Install backdraft dampers on inlet to exhaust fans and gravity ventilators used in relief air applications where shown on the drawings and schedules.

D. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.

E. Install safety screen where inlet or outlet is exposed.

F. Pipe scroll drains to nearest floor drain.

G. Install backdraft dampers on discharge of exhaust fans as indicated on Drawings. Refer to Section 23 33 00.

H. Provide sheaves required for final air balance.

I. Solder bottom joints and up 2 inches of side joints of duct under roof ventilator to prevent any moisture from entering ventilator.

3.04 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Requirements for manufacturer's field services.

B. Furnish services of factory trained representative for minimum of one days to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.05 CLEANING

A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of fan cabinet.

3.06 DEMONSTRATION

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate fan operation and maintenance procedures.

3.07 PROTECTION OF FINISHED WORK

A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers
3. Grilles.
4. Door grilles.
5. Louvers.
6. Gravity roof ventilators.

B. Related Sections:

1. Division 08 - Louvers: Wall Louvers.
2. Division 09 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
3. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Test Reports: Rating of air outlet and inlet performance.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Acceptance or no exceptions taken by the engineer on any substitution proposed by the contractor shall not be construed as relieving the contractor from compliance with the project's specifications and performance requirements nor departure there from. The contractor remains

responsible for details and accuracy for confirming and correlating quantities and dimensions and for the selection of fabrication processes, techniques and assembly, coordination of his work with that of all other trades and making any needed modifications consequent to the substitution at his own cost and for performing the work in a safe manner.

1.04 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70 and ADC 1062 "Certification, Rating and Test Manual".

B. NFPA Compliance: Install air outlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilation Systems".

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

1.09 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.01 CEILING AIR DIFFUSERS, REGISTERS, AND GRILLES

A. Acceptable Manufacturers:

1. Titus
2. Price
3. Anemostat

B. General:

1. Grilles, registers, diffusers and appurtenances shall conform to requirements specified herein and shall be of type and sizes as specified and indicated on Drawings.

Performance shall be in accordance with Air Diffusion Council Test Code 1602R2 including airflow velocity, pressure, temperature, and sound measurements. Noise level ratings shall be in accordance with ADC Test Code No. 1062RI and ASHRAE Standards 36 62 and 36B 3.

2. Sponge neoprene, rubber, vinyl or felt border gaskets shall be provided for surface-mounted registers, grilles or diffusers.
3. The noise generating characteristics of all specified grilles, registers, and diffusers shall be tested to, and comply with, all requirements of this specification. Representative samples shall be subjected to tests in accordance with applicable standards and procedures in order to demonstrate such compliance. A special test for this project is not required if the manufacturer has previous certified test results that can be made applicable to this project. Maximum Sound Levels of diffusers, grilles and registers shall be as follows:
   a. Administrative office area: NC 30
   b. Classrooms: NC 20
   c. Libraries and other noise sensitive areas: NC 25
4. Provide suitable frame types to match the ceiling types as specified or indicated on the Architectural Drawings
5. Ceiling mounted grilles, registers and diffusers shall be provided with a factory applied, baked enamel, finish per Architect's requirements.
6. Grilles or registers mounted on painted walls or other surfaces shall be furnished with a baked prime coat and finish painted to match Architectural requirements.
7. Do not provide opposed blade dampers at diffusers and registers to balance the airflow. Provide a manual volume damper at each branch take-off to each diffuser and register.
8. Diffusers, registers and grilles indicated or scheduled on the drawings to comply with special requirements shall take precedence over the standard items specified.

C. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

D. Finishes: Ceiling diffusers, registers and grilles: Finishes shall be coordinated with the Architect.

2.02 EXHAUST AND RETURN CEILING GRILLES

A. Acceptable Manufacturer:

1. Titus.
2. Price.
3. Anemostat.

B. Finish: Baked enamel, White or off-white as selected by the Architect.

C. Mounting: Surface mounted or Lay-in.

D. Provide filler panel when installed in 24" X 24" T-bar ceiling. Panel to match ceiling construction. For 24" x 48" T-bar ceilings, coordinate with ceiling installer for auxiliary tees as required to provide 24" x 24" space. Where full 24" x 24" grid module is not available, surface mount the outlet in center cut to fit ceiling tile.

E. Exhaust and return air ceiling grilles, shall be Titus 350RL or approved equal.

2.03 EXHAUST AND RETURN SIDE WALL GRILLES

A. Acceptable Manufacturer:

1. Titus.
2. Price.
3. Anemostat.

B. Finish: Baked enamel, White or off-white as selected by the Architect.

C. Face Arrangement: ½ blade spacing, 35 degree Fixed deflection

D. Frame: 1 ¼" wide

E. Mounting: Side wall

F. Exhaust air and return air sidewall grilles shall be Titus 350RL or approved equal.

2.04 CEILING SUPPLY DIFFUSERS

A. Acceptable Manufacturer

1. Titus.
2. Price.
3. Anemostat.

B. Finish: Baked enamel, White or off-white as selected by the Architect.

C. Pattern: Adjustable form 1-4 way throw.

D. Mounting: Surface mounted or Lay-in.

E. Provide filler panel when installed in 24" X 24" T-bar ceiling. Panel to match ceiling construction. For 24" x 48" T-bar ceilings, coordinate with ceiling installer for auxiliary tees as required to provide 24" x 24" space. Where full 24" x 24" grid module is not available, surface mount the outlet in center cut to fit ceiling tile.

2.05 SUPPLY SIDE WALL GRILLES

A. Acceptable Manufacturer:

1. Titus.
2. Price.
3. Anemostat.

B. Finish: Baked enamel, White or off-white as selected by the Architect.

C. Face Arrangement: ½" blade spacing, 1/8" bars at 15° deflection.

D. Frame: 1 ¼" wide

E. Mounting: Side wall

F. Supply air sidewall grilles shall be Titus CT-580 or approved equal.

2.06 LINEAR SLOT SUPPLY AND RETURN CEILING DIFFUSERS

A. Acceptable Manufacturer:

1. Titus.
2. Price.
3. Anemostat.

B. Finish: White, baked enamel or off-white as selected by the Architect.

C. Size: Refer to the floor plans for number and size of the slots.

D. Plenum: 12-inch tall with external insulation and vapor barrier.

E. Blank-Offs: Provide blank off panels where diffuser is not activated

F. Mounting: Surface mounted

G. Pattern: full 180 degree pattern controller (Adjustable)

H. Damper: Integral.

2.07 LOUVERS

A. Louvers: As specified in Division 08.

2.08 GRAVITY ROOF VENTILATOR

A. General:

1. Ventilator shall be low silhouette gravity type.
2. Ventilator shall be Greenheck, U.S. Fan or approved equal.

B. Features:

1. Housing shall be heavy gauge aluminum and bird screening covering the opening. Top shall be aluminum.
2. Finish shall be aluminum.
3. Unit shall set on built-up roof curb.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify inlet and outlet locations.

C. Verify ceiling and wall systems are ready for installation.

D. Verify exact air inlet and outlet type with equipment schedules on drawings and reflected ceiling plans.

3.02 INSTALLATION

A. Install diffusers to ductwork with airtight connection.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Division 23, Air Duct Accessories.

C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Division 09.

3.03 DIFFUSERS, REGISTERS AND GRILLES INSTALLATION

A. Coordination with Ceiling Features.

1. Install components to insure that all return air registers are located away from and in a netural position with respect to any Television, computer station, refrigerators, stoves, microwave ovens, doors and windows. The thermostat will be located such that it senses the average return air temperature most accurately. These requirements and all components will be outlined on the shop drawings from the HVAC contractor early in the submittal phase for the approval of the design engineer.
2. Install all inlets and outlets as close as possible to that shown on the plans but adjust to fit into the ceiling materials shown on the Architectural, Electrical and Fire Sprinkler plans. All ceiling mounted inlet and outlet devices shall be of the side inlet design and insulated for noise control.
3. In dry wall and plaster ceilings, diffuser, register or grilled trim shall overlap the plaster line with adequate trim.
4. In ceilings with acoustic tile adhesively applied to drywall or plaster ceilings, furnish diffusers, registers or grilles with overlapping margins.
5. In perforated metal plate systems: Square or rectangular diffuser and grille edge trim shall be flush with the finished ceiling.
6. Furnish and install plaster frames for diffusers, grilles and registers which are located on finish plaster surfaces. Plaster frames for grilles and registers shall be set flush with the finished surface and attached to ductwork by hickey punching, with rivets or sheet metal screws. Grilles and registers shall be fastened to the frames with sheet metal screws. All inlet and outlet devices shall be Casketed for air tight mounting.
7. Provide any intake duct not protected by a louver, grille or register with a 1/4" mesh galvanized screen over open end.
8. Paint all ductwork visible through grilles, registers, and other openings with one coat of flat black paint.

3.04 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 23 51 00

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Type B double wall gas vents.

B. Related Sections:

1. Division 03 - Concrete Forming and Accessories: Execution requirements for inserts specified by this section.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers and supports for placement by this section.
3. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
4. Section 23 52 39 – Heating Hot Water Boilers: Boilers using breeching, chimneys, and stacks.
5. Division 26 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.66 - Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
2. ANSI Z21.67 - Mechanically Actuated Automatic Vent Damper Device.
3. ANSI Z21.68 - Thermatically Actuated Automatic Vent Damper Devices.
4. ANSI Z95.1 - Oil Burning Equipment, Installation.

B. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
4. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
5. ASTM C401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories.

C. National Fire Protection Association:

1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
2. NFPA 54 - National Fuel Gas Code.

3. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.
4. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - Guide for Steel Stack Construction.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 378 - Draft Equipment.
2. UL 441 - Gas Vents.
3. UL 641 - Type L Low-Temperature Venting Systems.

1.03 DEFINITIONS

A. Breeching: Vent Connector.

B. Vent: Portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

C. Vent Connector: Part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.04 DESIGN REQUIREMENTS

A. Design stacks for wind loading and seismic loads for associated zones.

1.05 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittals procedures.

B. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breeching. Submit layout drawings indicating plan view and elevations.

C. Product Data: Submit data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

D. Product Data: Submit data on fans and accessories including fan curves with specified operating point plotted, power, RPM, and electrical characteristics and connection requirements.

E. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with State of California Public Work's]standard.

B. Maintain one copy of each document on site.

C. Provide factory built vents and chimneys used for venting natural draft appliances complying with NFPA 211 and UL listed and labeled.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.08 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements.

B. Maintain water integrity of roof during and after installation of chimney or vent.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for manufactured units.

PART 2 PRODUCTS

2.01 TYPE B DOUBLE WALL GAS VENTS

A. Manufacturers:

1. Amerivent.
2. Heatfab.
3. Metal Fab.
4. Substitutions: Division 01 - Product Requirements.

PART 3 EXECUTION

3.01 PREPARATION

A. Install concrete inserts for support of double wall flues in coordination with formwork.

3.02 INSTALLATION

A. Install in accordance with NFPA 54.

B. Install double wall flue with minimum of joints. Align accurately at connections, with internal surfaces smooth.

C. Coordinate installation of dampers, and induced draft fans.

D. For Type B double wall gas vents, maintain UL listed minimum clearances from combustibles. Assemble pipe and accessories for complete installation.

E. Install vent dampers, locating close to draft hood collar, and secured to breeching.

F. Level and plumb chimney and stacks.

G. Clean breeching, chimneys, and stacks during installation, removing dust and debris.

H. Install slip joints allowing removal of appliances without removal or dismantling of breeching, breeching insulation, chimneys, or stacks.

END OF SECTION

SECTION 23 52 39

HEATING HOT WATER BOILERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes gas-fired, copper finned-tube hydronic heating boilers

B. Related Sections

1. Building Services Piping – Section 23 21 13
2. Breeching, Chimneys, and Stacks (Venting) – Section 23 51 00
3. HVAC Instrumentation and Controls –Section 23 09 23
4. Electrical – Division 26

1.02 REFERENCES

A. ANSI Z21.13/CSA 4.9

B. ASME, Section IV

C. 2006 UMC, Section 1107.6

D. ANSI/ASHRAE 15-1994, Section 8.13.6

E. National Fuel Gas Code, NFPA 54/ANSI Z223.1

F. I=B=R

G. NEC

H. ASME CSD-1, 2009 (if required)

1.03 SUBMITTALS

A. Product data sheet (including dimensions, rated capacities, shipping weights, accessories)

B. Wiring diagram

C. Warranty information

D. Installation and operating instructions

1.04 QUALITY ASSURANCE

A. Regulatory Requirements

1. ANSI Z21.13/CSA 4.9
2. Local and national air quality regulations for low NOx (0-20 PPM NOx emissions) boilers

B. Certifications

1. CSA
2. ASME H Stamp and National Board Listed

1.05 WARRANTY

A. Limited one-year warranty from date of installation

B. Limited twenty-year thermal shock warranty

C. Limited ten-year closed-system heat exchanger warranty

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Raypak, Inc.

B. Or approved equal.

2.02 BOILERS

A. General

1. The boiler(s) shall be CSA tested and certified with a minimum thermal efficiency of 87 percent at full fire (88.4% at part load).
2. The boiler(s) shall be ASME inspected and stamped and National Board registered for 160 PSIG working pressure and 250°F maximum allowable temperature, complete with a Manufacturer's Data Report.

B. Heat Exchanger

1. The heat exchanger shall be of a single-bank, vertical multi-pass design and shall completely enclose the combustion chamber for maximum efficiency. The tubes shall be set vertically and shall be rolled into a powder coated, ASME boiler quality, carbon steel tube sheet.
2. The heat exchanger shall be sealed to 160 PSIG rated bronze headers with high temp silicone "O" rings.
3. The low water volume heat exchanger shall be explosion-proof on the water side and shall carry a twenty-year warranty against thermal shock.
4. The headers shall be secured to the tube sheet by stud bolts with flange nuts to permit inspection and maintenance without removal of external piping connections. A heavy gauge stainless steel slotted heat exchanger wrap shall ensure proper combustion gas flow across the copper-finned tubes.
5. The boiler shall be capable of operating at inlet water temperatures as low as 120°F without harmful condensation.
6. The primary heat exchanger shall have accessible boiler drain valves with hose bibs to drain the water section of the primary heat exchanger.

C. Burners

1. The combustion chamber shall be of the sealed combustion type employing a high temperature woven mesh burner, mounted in a vertical orientation.
2. The burner must be capable of firing at both a complete blue flame with maximum gas and air input as well as firing infrared when gas and air are reduced. The burner must be capable of firing at 100% of rated input when supplied with 4.0" WC of inlet gas pressure, so as to maintain service under heavy demand conditions; no exceptions.
3. The burner shall use a combustion air blower to precisely control the fuel/air mixture for maximum efficiency throughout the entire range of modulation. The combustion air blower shall operate for a pre-purge period before burner ignition and a post-purge period after burner operation to clear the combustion chamber.
4. The blower shall infinitely vary its output in response to a 4-20 mA signal supplied directly from the PID modulating temperature controller, thereby electronically and precisely adjusting the volume of air and gas supplied for combustion. Minimum fire shall be 25 percent of rated input.

D. Ignition Control System

1. The boiler shall be equipped with a 100 percent safety shutdown.
2. The ignition shall be Hot Surface Ignition type with full flame rectification by remote sensing separate from the ignition source, with a three-try-for-ignition sequence, to ensure consistent operation.
3. The igniter will be located to the side of the heat exchanger to protect the device from condensation during start-up.
4. The ignition control module shall include an LED that indicates six (6) individual diagnostic flash codes.
5. An external viewing port shall be provided, permitting visual observation of burner operation.

E. Gas Train

1. The boiler shall have a firing/leak test valve and pressure test valve as required by CSD-1.
2. The boiler shall have dual-seated main gas valve.
3. Gas control trains shall have a redundant safety shut-off feature, main gas regulation, shut-off cock and plugged pressure tapping to meet the requirements of ANSI Z21.13/CSA 4.9.

F. Boiler Control

1. The following safety controls shall be provided:
   a. High limit control with manual reset
   b. Flow switch, mounted and wired.
   c. ASME pressure relief valve, piped by the installer to an approved drain.
   d. Temperature and pressure gauge.

2. The boiler(s) shall be equipped with a PID modulating temperature controller with LCD display that incorporates an adjustable energy-saving pump control relay and is factory mounted and wired to improve system efficiency; water sensors included.

G. Firing Mode: Provide electronic modulating control of the gas input to the boiler.

H. Boiler Diagnostics

1. Provide external LED panel displaying the following boiler status/faults:
   a. Power on
   b. Call for heat
   c. Burner firing
   d. Service

2. Provide internal circuit board indicating the following safety faults by a 2 line, 20 character, LCD display:
   a. System status
   b. Manual reset high limit
   c. Blocked vent
   d. Controller alarm
   e. Flow switch
   f. Air pressure
   g. Factory option
   h. External interlock
   i. Cold Water Start/Cold Water Run
   j. Ignition lock-out
   k. Auto reset high limit (optional)
   l. Low water cut-off (optional)
   m. Low gas pressure switch (optional)
   n. High gas pressure switch (optional)

3. Provide ignition module indicating the following flash codes by LED signal and displayed on LCD display:
   a. 1 flash – low air pressure
   b. 2 flashes – flame in the combustion chamber w/o CFH
   c. 3 flashes – ignition lock-out (flame failure)
   d. 4 flashes – low hot surface igniter current
   e. 5 flashes – low 24VAC
   f. 6 flashes – internal fault (replace module)

I. Combustion Chamber: The combustion chamber wrapper shall be sealed to reduce standby radiation losses, reducing jacket losses and increasing unit efficiency.

J. Cabinet

1. The corrosion resistant galvanized steel jackets shall be finished with a baked-on epoxy powder coat, which is suitable for outdoor installation, applied prior to assembly for complete coverage, and shall incorporate louvers in the outer panels to divert air past heated surfaces.
2. The boiler, if located on a combustible floor, shall not require a separate combustible floor base.
3. The boiler(s) shall connect both the combustion air and flue products through the back of the unit.

K. Boiler Pump –Integral circulating pump, factory installed.

L. Cold Water Run System

1. The boiler shall be configured with a cold water run automatic proportional bypass system that ensures the water heater will experience inlet temperatures in excess of 120°F in less than 7 minutes to avoid damaging condensation. The unit will automatically shut down if the inlet temperature is not achieved within the 7 minute time frame.
2. The cold water run system shall be configured with a variable speed pump that is controlled by a system-matched PID control that injects the correct amount of cold water directly into the water heater loop to maintain a minimum inlet temperature. The PID controller temperature sensor shall be located in the inlet header of the water heater.
3. The control shall have a temperature setting dial located on the face of the board. The temperature range of the dial shall be 105°F to 120°F. The PID Logic shall be capable of limiting system overshoot to a maximum of 10°F on initial start-up or call-for-heat.
4. The cold water start system shall be completely wired and mounted at the factory.
5. The control shall have the following diagnostic LED's:
   a. Call for heat
   b. Start-up mode
   c. Inlet temperature error
   d. Sensor out of range
6. The controller shall have alarm contacts.

2.03 BOILER OPERATING CONTROLS

A. The boiler shall feature a modulating digital controller with selectable outdoor reset mode option, mounted and wired.

B. System sensor and optional air temperature sensor shall be shipped loose for field installation by installing contractor. Inlet/Outlet sensors are factory-installed.

2.04 DIRECT VENT

A. The boiler(s) shall meet safety standards for direct vent equipment as noted by the 2003 Uniform Mechanical Code, sections 802.2.5 and 1107.6, and ASHRAE 15-1994, section 8.13.6.

2.05 SOURCE QUALITY CONTROL

A. The boiler(s) shall be completely assembled, wired, and fire-tested prior to shipment from the factory.

B. The boiler(s) shall be furnished with the sales order, ASME Manufacturer's Data Report, inspection sheet, wiring diagram, rating plate and Installation and Operating Manual.

PART 3 EXECUTION

3.01 INSTALLATION

A. Must comply with:

1. Local, state, provincial, and national codes, laws, regulations and ordinances
2. National Fuel Gas Code, NFPA 54/ANSI Z223.1 – latest edition
3. National Electrical Code, ANSI/NFPA 70 – latest edition

4. Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1, when required
5. Manufacturer's installation instructions, including required service clearances and venting guidelines

B. Manufacturer's representative to verify proper and complete installation.

3.02 START-UP

A. Shall be performed by Raypak factory-trained personnel.

B. Test during operation and adjust if necessary:

1. Safeties
2. Operating Controls
3. Static and full load gas supply pressure
4. Gas manifold and blower air pressure
5. Amp draw of blower

C. Submit copy of start-up report to Architect and Engineer.

3.03 TRAINING

A. Provide factory-authorized service representative to train maintenance personnel on procedures and schedules related to start-up, shut-down, troubleshooting, servicing, and preventive maintenance.

B. Schedule training at least seven days in advance.

END OF SECTION

SECTION 23 65 00

COOLING TOWERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes packaged cooling tower with structure, casing, fill and basin, controls, heaters fans, motors and drive equipment, condensing water inlet and outlet with internal distribution and ladder and handrails.

B. Related Sections:

1. Division 03 - Cast-In-Place Concrete: Execution requirements for concrete bases specified by this section.
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric drive motors for placement by this section.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Execution requirements for steel support bases specified by this section.
4. Section 23 21 13 - Hydronic Piping: Product requirements for condenser water piping for placement by this section.
5. Section 23 25 00 - HVAC Water Treatment: Product and execution requirements for cooling tower water chemical treatment equipment.
6. Division 26 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.02 REFERENCES

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:

1. ASME PTC 23 - Atmospheric Water Cooling Equipment.

D. ASTM International:

1. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. Cooling Technology Institute:

1. CTI - Acceptance Test Code.
2. CTI 201 - Certification Standard for Commercial Water Cooling Towers.

F. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.03 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate structural steel supports including dimensions and locations for mounting-bolt holes.

C. Product Data: Submit rated capacities, dimensions, weights and point loads, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls. Submit performance curve plotting leaving water temperature against wet bulb temperature.

D. Field Test Reports: Indicate compliance with specified performance.

E. Manufacturer's Certificate: Certify cooling tower performance meets or exceeds specified requirements.

F. Manufacturer's Field Reports: Submit start-up report for each unit. Indicate compliance with field test.

1.04 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories.

1.05 QUALITY ASSURANCE

A. Construction and rating in accordance with CTI Acceptance Test Code and CTI 201.

B. Performance Ratings: Required performance not less than prescribed by ASHRAE 90.1 when tested in accordance with CTI Acceptance Test Code and CTI 201.

C. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Follow manufacturer's installation instructions for rigging, unloading, and transporting units.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for corrosion resistance of cooling tower structure, cooling tower package, fan drive, motor labor and materials.

1.11 MAINTENANCE SERVICE

A. Division 01 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Include systematic examination, adjustment, and lubrication of unit, including fan belt replacement, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

C. Perform work without removing units from service during building normal occupied hours.

D. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

E. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.

1.12 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of matched fan belts.

C. Furnish two spray nozzles for each cell.

D. Furnish two gaskets for each access door.

E. Furnish one valve seat for each make-up or control valve.

PART 2 PRODUCTS

2.01 COOLING TOWERS

A. Manufacturers:

1. Baltimore Aircoil.
2. EVAPCO.
3. Substitutions: Division 01 - Product Requirements.

B. Product Description: factory assembled, sectional, counter flow, induced draft design, with fan and motor assemblies, built with pan, casing, fill and drift eliminators.

2.02 STEEL COOLING TOWERS

A. Framing and Casing: Galvanized steel, 12 gage for casing and 8 gage for reinforcing angles and channels with access doors at both ends of tower to air plenum.

B. Basin: 316 stainless steel.

C. Induced Draft Fan: Axial cast aluminum multi-blade, fixed pitch.

1. Drive: Geared, right angle drive with ABMA 9 or ABMA 11 L-10 life expectancy of 40,000 hours bearings and drive shaft equipped with non-lubricated flexible couplings.
2. Motor: Single-speed, VFD rated, with special moisture protection, mounted on welded steel frame in fan deck.
3. Fan Cylinder: One-piece, welded steel, hot dipped galvanized fan assembly.

D. Belt Drive: Designed for minimum 150 percent motor nameplate power.

E. Fan Guard: Welded steel rod and wire guard, hot dipped galvanized after fabrication.

F. Safety: Safety railings, and ladder from grade to fan deck.

G. Distribution Section: Polyvinyl chloride piping header and branches with ABS plastic spray nozzles.

H. Fill material: Self-supporting, fluted, polyvinyl chloride.

I. Drift Eliminators: Two or three-pass polyvinyl chloride plastic to limit drift loss to 0.2 percent of total water circulated.

J. Float Valves: Brass or bronze balanced piston type make-up valve with plastic or copper float.

K. Hardware: Stainless steel nuts, bolts, and washers.

L. Finish of steel components: Hot dipped galvanized steel with minimum 2.10 oz/sf zinc coating both sides measured in accordance with ASTM A90/A90M and zinc chromatized aluminum paint.

M. Provide electro-mechanical vibration switch for each tower interlock with respective motor and the EMS.

N. Accessories: Provide factory installed PVC basin sweeper with fixed set nozzles.

O. Capacity: Per Contract Drawings.

P. Provide integral shut-off valve at equalizer opening between the tower cells.

2.03 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Division 26:

B. Motors: Inverter Duty, premium efficiency.

C. Disconnect Switch: Factory-mount on equipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify support is ready to accept tower.

B. Verify dimensions of support are as shown on shop drawings.

3.02 INSTALLATION

A. Install tower on structural steel beams or concrete base in accordance with manufacturer's published instructions.

B. Install tower on steel I-beams.

C. Install condenser water piping with flanged connections to tower. Pitch condenser water supply to tower and condenser water suction away from tower. Refer to Section 23 21 13.

D. Install make-up water piping with flanged or union connections to tower. Pitch to tower.

E. Install overflow, bleed, and drain, to floor drain.

3.03 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test for capacity under actual operating conditions in accordance with CTI Acceptance Test Code and verify specified performance.

3.04 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Manufacturers' field services.

B. Supervise rigging, hoisting, and installation.

C. Inspect tower after installation and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturers recommendations.

3.05 ADJUSTING

A. Division 01 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust bleed, control settings and airflow.

3.06 DEMONSTRATION AND TRAINING

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate starting, maintenance and operation of tower.

3.07 SCHEDULES

A. Cooling Towers: Per Contract Drawings.

END OF SECTION

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air handling unit or fan coil unit.
2. Condensing unit.

B. Related Sections:

1. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
2. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
3. Section 23 33 00 - Air Duct Accessories: Flexible connections.
4. Division 26- Equipment Wiring Connections: Electrical connection to units.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data indicating:

1. Cooling and heating capacities.
2. Dimensions.
3. Weights.
4. Rough-in connections and connection requirements.
5. Electrical requirements with electrical characteristics and connection requirements.
6. Controls.
7. Accessories.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

E. Manufacturer's Field Reports: Submit start-up report for each unit.

1.04 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of controls installed remotely from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.05 QUALITY ASSURANCE

A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.

B. Cooling Capacity: Rate in accordance with ARI 210/240.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

E. Perform Work in accordance with State of California standards.

F. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.09 COORDINATION

A. Division 01 - Administrative Requirements: Requirements for coordination.

B. Coordinate installation of condensing units with roof structure.

C. Coordinate installation of air handling units with building structure.

1.10 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five year manufacturer's warranty for compressors.

1.11 MAINTENANCE SERVICE

A. Division 01 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.

C. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within hours.

1.12 MAINTENANCE MATERIALS

A. Division 01 - Execution and Closeout Requirements: Requirements for maintenance materials.

PART 2 PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Manufacturers:

1. Mitsubishi
2. Sanyo
3. Substitutions: Division 01 - Product Requirements.

B. Product Description: Split system consisting of air handling unit or fan coil unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.02 FAN COIL UNIT

A. General: Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware.

B. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.

C. Fans:

1. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
2. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.

D. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.

E. Motor: Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

F. Controls:

1. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 62 deg F to 84 deg F.
2. User interface with the unit shall be accomplished through the standard wireless remote control or an optional wired controller or Zone Manager. The unit shall have the following functions as a minimum:
   a. An automatic restart after power failure at the same operating conditions as at failure.
   b. A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
   c. Temperature-sensing controls shall sense return air temperature.
   d. Indoor coil freeze protection.
   e. Automatic air sweep control to provide on or off activation of air sweep louvers.
   f. Fan-only operation to provide room air circulation when no cooling is required.
   g. Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.

G. Filters: Unit shall have filter track with factory-supplied cleanable filters.

H. Refrigerant Lines: All units should have refrigerant lines that can be oriented to connect from the left, right or back of the unit. Both refrigerant lines need to be insulated.

2.03 CONDENSING UNIT

A. Air-Cooled Condensing Unit (Outdoor Unit):

1. System Description:
   a. Outdoor-mounted, air-cooled, split-system air conditioning unit suitable for ground or rooftop installation. Unit shall consist of a scroll compressor, and air-cooled coil, propeller-type blow-thru condenser fan, accumulator, full refrigerant charge, and control box.
   b. Unit shall discharge supply air HORIZONTALLY as shown on contract drawings.
   c. Unit shall be used in a condensing unit circuit to match up to a fan coil unit.

2. Quality Assurance:
   a. Unit shall be rated in accordance with the latest edition of ARI Standard 210, and be certified for capacity, efficiency, and listed in the latest ARI directory.
   b. Unit construction shall comply with latest edition of ANSI/ASHRAE and with NEC.
   c. Unit shall be constructed in accordance with UL standards and carry the UL label of approval.
   d. Unit cabinet shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test.
   e. Air-cooled condenser coils shall be leak tested at 150 psig and pressure tested at 300 psig.

3. Equipment:
   a. Factory-assembled, single-piece air-cooled condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, refrigerant charge (R410A), and special features required prior to field start-up.
   b. Unit cabinet shall be constructed of galvanized steel, bonderized, and coated with powder coat paint.
   c. Condenser fan shall be direct-drive propeller type, discharging air horizontally. Condenser fan motors shall be totally enclosed, 1-phase type with class B insulation and permanently lubricated bearings. Shafts shall be corrosion resistant and fan blades shall be statically and dynamical balanced.
   d. Condenser fan openings shall be equipped with PVC-coated steel wire safety guards.
   e. Compressor will be hermetically sealed and mounted on rubber vibration isolators.
   f. Condenser coil shall be air cooled and constructed of aluminum fins mechanically bonded to copper tubes, cleaned, dehydrated, and sealed.
   g. Refrigeration circuit components shall include liquid line shutoff valve with sweat connections, suction line shutoff valves with sweat connections, system charge of refrigerant R410A, compressor oil, accumulator, bi-flow filter drier and pressure relief.

2.04 CONTROLS

A. Thermostat: Remote space thermostat with single stage cooling. Furnish system selector switch off-cool.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify concrete pad for condensing unit is ready for unit installation.

3.02 INSTALLATION - AIR HANDLING UNIT (FAN COIL UNIT)

A. Install air handling units as recommended by manufacturer on vibration isolators.

B. Refer to Section 23 33 00.

C. Install condensate piping with trap and route from drain pan to condensate drainage system. Refer to Section 23 21 13.

D. Install components furnished loose for field mounting.

E. Install connection to electrical power wiring in accordance with Division 26.

3.03 INSTALLATION - CONDENSING UNIT

A. Install condensing units on vibration isolators.

B. Install units on equipment platforms.

C. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit.

D. Evacuate refrigerant piping and install initial charge of refrigerant.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring between air handling unit, condensing unit, and field installed accessories.

G. Install connection to electrical power wiring in accordance with Division 26.

3.04 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Requirements for manufacturer's field services.

B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.05 CLEANING

A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of unit cabinet.

C. Install new throwaway filters in units at Substantial Completion.

3.06 DEMONSTRATION

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate air handling unit operation and maintenance.

C. Demonstrate starting, maintenance, and operation of condensing unit including low ambient temperature operation.

D. Furnish services of manufacturer's technical representative for one 4-hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.07 PROTECTION OF FINISHED WORK

A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 23 81 46

WATER-SOURCE UNITARY HEAT PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Vertically mounted water source heat pumps.

B. Related Sections:

1. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
2. Section 23 21 13 - Hydronic Piping: Water and drain piping connections.
3. Section 23 33 00 - Air Duct Accessories: Flexible connections.
4. Division 26 - Equipment Wiring Connections: Electrical connection to units.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 320 - Water Source Heat Pump Equipment.
4. ARI 330 - Ground Source Closed-Loop Heat Pump Equipment.
5. ARI 325 - Ground Water Source Heat Pump Equipment.
6. ARI 350 - Sound Rating of Non-Ducted Indoor Air Conditioning Equipment.

B. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. International Organization for Standardization:

1. ISO 13256-1 - Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps.

F. National Electrical Manufacturers Association:

1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

G. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

H. Underwriters Laboratories, Inc.:

1. UL 1995 - Heating and Cooling Equipment.

1.03 DEFINITIONS

A. Coefficient of Performance (COP), heat pump, heating - Ratio of rate of heat delivered to rate of energy input, in consistent units, for complete heat pump system, including compressor and, if applicable, auxiliary heat, under designated operating conditions.

B. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data indicating:

1. Cooling and heating capacities.
2. Dimensions.
3. Rough-in connections and connection requirements.
4. Duct connections.
5. Controls.
6. Accessories.
7. Installation, operation and service clearances. Indicate lift points and recommendations and center of gravity.
8. Indicate unit shipping, installation and operating weights.
9. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or maximum circuit ampacity.

C. Test Reports: Submit results of factory test at time of unit shipment.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturer's Field Reports: Submit start-up report for each unit.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of controls installed remotely from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data. Include parts list and wiring diagrams.

1.06 QUALITY ASSURANCE

A. Cooling Performance Requirements: Conform to minimum EER prescribed by ASHRAE 90.1 when tested in accordance with ISO 13256-1.

B. Heating Performance Requirements: Conform to minimum COP prescribed by ASHRAE 90.1 when tested in accordance with ISO 13256-1.

C. Performance ratings in accordance with ISO 13256-1.

D. Sound Rating: Measure in accordance with ISO 13256-1.

E. Insulation and adhesives: Meet requirements of NFPA 90A.

F. Perform Work in accordance with County of Riverside standards.

G. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.08 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept units on site. Inspect for damage.

C. Comply with manufacturers installation instructions for rigging, unloading and transporting units.

D. Protect units from damage by storing in manufacturer's packaging until ready for installation.

1.10 COORDINATION

A. Division 01 - Administrative Requirements: Requirements for coordination.

B. Coordinate unit installation with roof structure, piping systems, and ceiling for unit access.

1.11 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five year manufacturer's warranty for compressors.

1.12 MAINTENANCE SERVICE

A. Division 01 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Provide maintenance items shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.

C. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period.

1.13 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish one set of filters and fan belts for each unit.

PART 2 PRODUCTS

2.01 VERTICAL WATER SOURCE HEAT PUMPS

A. Manufacturers:

1. Water Furnace International.
2. FHP Manufacturing, Inc.
3. McQuay International.
4. The Trane Company.
5. Carrier Corp.

B. Furnish materials in accordance with County of Riverside standards.

C. Cabinet: Factory assembled and wired consisting of galvanized steel cabinet with 1/2 inch thick glass fiber insulation on interior, discharge duct collar and return collar with filter rack.

1. Hanging Brackets: Located at each corner, and capable of receiving vibration isolation.

D. Motor and Fan Assembly - 1/2 ton to 6 ton:

1. Drive: Direct type.
2. Motor: Three speed high efficiency permanent split capacitor with permanently lubricated and sealed bearings and internal thermal overload protection.
   a. Furnish high external static pressure motors as indicated on Drawings.

3. Fan Discharge: Field convertible for back, left, or right discharge.

4. Motor and fan wheel: Removable.

E. Motor and Fan Assembly - 7 ton to 10 ton:

1. Drive: Belt type with adjustable sheaves.
2. Provide access to blower motor and motor belt or drive assembly through back or side panels.

F. Air-to-Refrigerant Coil:

1. Constructed of copper tubes mechanically expanded into aluminum fins; leak tested at 450 psi operating pressure; tubes completely evacuated of air prior to shipment.
2. Refrigerant coil distributor assembly: orifice style with round copper distributor tubes sized consistent with capacity of coil; suction headers fabricated from rounded copper pipe.

G. Drain Pan: Constructed of corrosion resistant material and insulated to prevent sweating. Bottom sloped in two directions.

H. Water-to-Refrigerant Heat Exchanger:

1. Co-axial type; constructed of copper; fluted to enhance heat transfer and minimize fouling and scaling.
2. Working pressure: 450 psi on refrigerant side and 400 psi on water side.

I. Refrigeration System:

1. Compressor: Rotary, or scroll type. Furnish with:
   a. External vibration isolation.
   b. Thermal overload protection.

2. Reversing Valve: Pilot operating sliding piston type with replaceable encapsulated magnetic coil. Valve energized in cooling mode.
3. Refrigerant Tubing: Constructed of copper; free from contaminants and conditions such as drilling fragments, dirt, and oil.
4. Insulation: Refrigerant and water piping internal to unit insulated with 3/8 inch thick elastomeric insulation.
5. Refrigerant Metering: Furnish with thermal expansion valve (TXV). Capillary tubes may be used only when unit is furnished with water-regulating valve.
6. Refrigerant Access Ports: Factory supplied on high and low pressure sides for easy refrigerant pressure or temperature testing.

J. Filters: 2 inch thick throwaway type, MERV 13.

K. Control Panel: Factory tested and installed containing devices to allow heating and cooling operation to occur from remote device. Furnish the following:

1. 24 volt AC contactor for compressor control.
2. Terminal strip.
3. Safety lockout relay to prevent cycling of compressor during adverse conditions of operation. Capable of being reset at remote thermostat or zone sensor or by cycling power to unit.
4. High pressure switch.
5. Low pressure switch.

L. Controls: Factory-wired, tested, and commissioned. Each water source heat pump controlled by communicating microprocessor based controller with resident control logic. Furnish controller with the following features:

1. 24 volt AC control transformer with integral circuit breaker.
2. Random start.
3. Anti-short cycle protection.
4. Condensate overflow safeties.
5. Brownout protection.
6. Furnish status for the following:
   a. Heating or cooling.
   b. Occupied or unoccupied cycle.
   c. Fan.
   d. Filter.
7. Low water temperature sensor.
8. Ability to control to four set points: occupied, occupied standby, occupied bypass (timed-override), and unoccupied.
9. Capability of receiving the following commands from Building Management System: mode - occupied and unoccupied, demand limiting sequence, emergency shutdown, and time-of-day scheduling.
10. Field service interface for diagnostic and troubleshooting purposes.
11. Capability of communicating specific diagnostics, not general alarm, to Building Management System:
    a. Space set point.
    b. Discharge air temperature.
    c. Leaving water temperature.
    d. Unit alarms with manual reset include: high pressure, low pressure, and condensate overflow.
    e. Unit alarms with automatic reset include: fan and filter status and low water temperature.
12. Building Management System: Interface control module to Building Management System furnished and factory mounted by manufacturer. Through this interface module, perform Building Management functions. Refer to Section 23 09 23. Furnish controls and sensors factory mounted. Limit field connection to Building Management System to single communication link.
13. Zone thermostat with one set point and override button.

M. Free Cooling: Economizing coil capable of using moderate temperature loop water to provide cooling without operating unit compressor. Furnish controls with water temperature sensor and two-position, diverting valve.

N. Hot Gas Reheat: Coil constructed of copper tubes mechanically expanded onto aluminum fins. Coil leak tested at 450 psi operating pressure. For humidity control, furnish with remotely mounted humidistat.

O. Hydronic Piping Specialties: Furnish unit with the following:

1. Ball Valves: Brass body, memory, memory stop, and pressure temperature ports.
2. Strainers: Bronze body, Y type configuration with stainless steel strainer screen.
3. Hoses: For supply and return connections. Constructed of stainless steel outer braid with inner core of tube made of nontoxic synthetic polymer material. Suitable for water temperatures ranging between 33 degrees F and 211 degrees F.

4. Supply and Return Hose Kit Assembly: For supply and return connections. Hose constructed of stainless steel outer braid with inner core of tube made of nontoxic synthetic polymer material. Suitable for water temperatures ranging between 33 degrees F and 211 degrees F. Includes ball valve with pressure temperature plug ports, flexible stainless steel hose with swivel and nipple.

P. Automatic Flow Devices: Automatic self-balancing device to limit flow rate within 10 percent of scheduled flow rate, over 40 to 1 differential pressure operating range of 2 psi to 80 psi differential. Operating temperature range: from freezing to 225 degrees F. Furnish with dual pressure-temperature test ports.

Q. Motorized Water Valve: Opens when compressor is energized, and closes as compressor shuts down. Furnish valve with fast opening and slow closing characteristics.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify concrete housekeeping pad is sized and located correctly.

C. Verify piping rough-in is at correct location.

D. Verify electrical rough-in is at correct location.

3.02 INSTALLATION

A. Locate units as indicated on Drawings, level and shim units, and anchor to structure.

B. Connect units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.

C. Make connections to coils with unions or flanges.

D. Install hydronic piping accessories on condenser water piping furnished with unit.

E. Install valves and piping specialties in accordance with details as indicated on Drawings.

F. Install automatic air vents at high points complete with shutoff valve. Refer to Section 23 21 13.

G. Install condensate piping with trap and route from drain pan to condensate drainage system. Refer to Section 23 21 13.

H. Install components furnished loose for field mounting.

I. Install electrical devices furnished loose for field mounting.

J. Install control wiring between unit and field installed accessories.

K. Locate remote panels as indicated on Drawings.

3.03 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Requirements for manufacturer's field services.

B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.04 CLEANING

A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of unit cabinet.

C. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.

D. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.05 DEMONSTRATION

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate unit operation and maintenance.

C. Furnish services of manufacturer's technical representative for one 4- hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner. Provide minimum 7 days notice to Architect/Engineer of training date.

3.06 PROTECTION OF FINISHED WORK

A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect finished surfaces of cabinets with protective covers during remainder of construction.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS ON ELECTRICAL

PART 1 GENERAL

1.01 SCOPE

A. This section supplements all sections of this division and shall apply to all phases of work hereinafter specified, shown on the drawings, or required to provide a complete installation of electrical systems for the Project. The work required under this division is not limited to the Electrical Drawings. Refer to Site, Architectural, Structural, and Mechanical Drawings which may designate Work to be accomplished. The intent of the Specifications is to provide a complete electrical system which include all documents which are a part of the Contract.

1. Work included: Furnish all labor, material, tools, equipment, facilities, transportation, skilled supervision necessary for, and incidental to, performing operations in connection with furnishing, delivery, and installation of the work in this section complete as shown or noted on the Drawings and specified herein.

B. Related Work Specified Elsewhere: Refer to all sections in Division 0, Contract Requirements and Division 1, General Requirements.

C. Work Installed but Furnished by Others: The electrical work includes the installation or connection of certain materials and equipment furnished by others. Verify installation details. Foundations for apparatus and equipment will be furnished by others unless otherwise noted or detailed.

1.02 GENERAL REQUIREMENTS

A. Guaranty See General Conditions and Division 01 – Execution and Closeout Requirements:

1. Except as may be specified under other Sections in the specification, guarantee equipment furnished under the specifications for a period of one year, except for equipment required to have a longer guaranty period, from date of Substantial Completion against defective workmanship and material, and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.
2. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner or his service agency as approved. Furnish to the Owner, through the Architect, printed manufacturer's warranties complete with material included and expiration dates, upon completion of project. Conform to Division 01 – Execution and Closeout Requirements.

B. Equipment Safety: All electrical materials and equipment shall be new and shall be listed by Underwriter's Laboratories and bear their label, or listed and certified by a nationally recognized testing authority where UL does not have an approval. Custom made equipment must have complete test data submitted by the manufacturer attesting to its safety. Provide signage at all electrical rooms and on each exterior electrical enclosure access door or gate. Sign shall read "DANGER-HIGH VOLTAGE". Provide signage on each door or removable access panel on electrical equipment rated 600 volts and over. Sign shall read "DANGER-HIGH VOLTAGE".

C. Codes and Regulations:

1. Design, manufacture, testing and method of installation of all apparatus and materials furnished under the requirements of these specifications shall conform to the latest publications or standard rules of the following:

Institute of Electrical and Electronic Engineers - IEEE
National Electrical Manufacturers' Association - NEMA
Underwriters' Laboratories, Inc. - UL
National Fire Protection Association - NFPA
American Society for Testing and Materials - ASTM
American National Standards Institute - ANSI
California Electrical Code - CEC
California Code of Regulations, Title 8, Subchapter 5
California Building Code
State & Municipal Codes in Force in the Specific Project Area
Occupational Safety & Health Administration - OSHA
California State Fire Marshal - CSFM

The term "Code", when used within the specifications, shall refer to the Publications, Standards, ordinances and codes, listed above. In the case where the codes have different levels of requirements the most stringent rules shall apply.

D. Requirements of Regulatory Agencies:

1. Codes, Permits, and Fees: Where the Contract Documents exceed minimum requirements, the Contract Documents take precedence. Where code conflicts occur, the most stringent shall apply unless variance is approved.
   a. Comply with all requirements for permits, licenses, fees and Code. Permits, licenses, fees, inspections and arrangements required for the work shall be obtained by the Contractor at his expense, unless otherwise specified.

E. Shop Drawings:

1. See Division 01 – Administrative Requirements: Submittal Procedures for additional requirements.
2. Time Schedules for Submission and Ordering: The Contractor shall prepare, review and coordinate his schedule of submissions carefully, determining the necessary lead time for preparing, submitting, checking, ordering and delivery of materials and equipment for timely arrival. The Contractor shall be responsible for conformance with the overall construction schedule.
3. Submittals will be checked for general compliance with specifications only. The Contractor shall be responsible for deviations from the drawings or specifications and for errors or omissions of any sort in submittals.
4. Submit a complete list of materials and equipment proposed for the job, including manufacturers names and catalog numbers.
5. Shop drawings shall be submitted in completed groups of materials (i.e., lighting fixtures or switchgear). The Contractor shall add and sign the following paragraph on equipment and materials submitted for review. "It is hereby certified that the (equipment) (material) shown and marked in this submittal is that proposed to be incorporated into the project; is in compliance with the Contract Drawings and specifications and can be installed in the allocated spaces". Failure to add the above written statement for compliance will result in return of submittals to be reviewed.

a. Bind catalog cuts, plate numbers, descriptive bulletins and drawings, 11" x 17" or smaller, in sets with covers neatly showing titles.
b. The Contractor shall verify dimensions of equipment and be satisfied as to Code compliance for fit prior to submitting shop drawings for approval.
c. Where current limiting devices are specified, submit technical data to substantiate adequate protection of equipment cascaded downstream. Submittals shall not be reviewed unless supporting calculations and data are submitted therewith.
d. Include complete catalog information such as construction, ratings and insulation systems, as applicable.
e. For any material specified to meet UL or trade standards, furnish the manufacturer or vendor's certification that the material furnished for the work does in fact equal or exceed such specifications.
f. Reference listings to the specifications' Sections and Article to which each is applicable.
g. Equipment Floor Plans: After approval of material is secured, prepare a floor plan of each electrical communication, and voice/data equipment room, drawn to scale at 1/2 inch equals 1 foot and submit for approval prior to rough-in in the same manner as for shop drawings. The layout drawings shall be exact scale. Equipment dimensions shall not exceed those indicated on the drawings. If proposed equipment exceeds these dimensions, it shall be the responsibility of the contractor to coordinate all equipment arrangement within the room with all affected trades to provide all code clearances and proper arrangements prior to rough-in. Equipment that grossly exceeds the space allocated and would require an increase in room size is not acceptable.

6. Contractor shall prepare coordinated drawings when required by Division 01 – Administrative Requirements: Submittal Procedures.

F. Interpretations: Requests for interpretations of drawings and specifications must be made by the Contractor through the Architect. Any such requests made by equipment manufacturers or suppliers will be referred to the Contractor.

G. Substitutions: Refer to General Conditions.

H. Submit comprehensive material list, shop drawings and complete technical data for the following equipment and materials:

1. General Requirements:
   a. Main service and distribution switchboards.
   b. Panelboards.
   c. Conduits
   d. Conductors, include selected insulation type.
   e. Fuses
   f. Disconnect switches.
   g. Pullboxes, manholes and handholes.
   h. Standard lighting fixtures, specially fabricated fixtures, ballasts and lamps, with samples and sample of standard finish available (where requested).
   i. Control devices, standard and special receptacles, switches, plug strips and finish device plates.
   j. Cabinets for signal and telephone system, special terminals and cabinets.
   k. Fire alarm system.
   l. Communication and Intrusion Detection systems.

I. Record Drawings: Refer to Division 01 – Execution and Closeout Requirements.

J. Work Responsibilities:

1. The drawings indicate diagrammatically the desired locations or arrangement of conduit runs, outlets and equipment and are to be followed. Execute the work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations. The Contractor is responsible for the correct placing of his work.
2. Locations shown on architectural plan or on wall elevations shall take precedence over electrical plan locations, but where a major conflict is evident, notify the Architect before installing any rough-in conduit underground or above ground.
3. In the event changes in the indicated locations or arrangement are necessary due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost.
4. Verify dimensions and the correct location of Owner-Furnished equipment before proceeding with the roughing-in of connections.
5. Lighting fixtures in mechanical spaces and elevator machine rooms are shown in their approximate locations only. Do not install light outlets or fixtures until mechanical piping and ductwork are installed; then lights shall be installed in locations best suited for equipment arrangement as directed by the Architect.
6. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with work carefully check and verify dimensions and sizes with the drawings to see that the equipment will fit into the spaces provided without violation of applicable Codes.
7. Should any changes to the work indicated on the drawings or described in the specifications be necessary in order to comply with the above requirements, notify the Architect.
8. Be responsible for coordination of coordinated drawings.
9. Replace or repair, without additional compensation, any work which does not comply with these requirements.

K. Installation General: For special requirements, refer to specific equipment under these requirements.

1. Unless otherwise specified elsewhere in the specifications, do all excavating necessary for the proper installation of the electrical work.
2. Locations of Openings: Locate chases, shafts and openings required for the installation of the electrical work during framing of the structure. Do any additional cutting and patching required. Cutting or drilling in any structural member is prohibited without approval of the Architect. Furnish access panels as required.
3. Location of Sleeves: Where conduits pass through concrete walls, suspended slabs or metal deck floors, install sleeves of adequate size to permit installation of conduit. Sleeves shall be installed prior to pouring of concrete and shall have ends flush with the wall or extend 2 inches above floor surfaces. Verify locations.
4. Type of Sleeves: Sleeves shall be steel pipe or galvanized sheet steel.
5. Finish Around Sleeves: Rough edges shall be finished smooth. Space between conduit and sleeves where conduit passes through exterior walls shall be sealed to permit movement of conduit, but prevent entrance of water. Space between conduit and sleeves where conduit passes through fire rated interior walls and slabs shall be sealed with approved materials to provide a fire barrier conforming to the requirements of the governing authorities having jurisdiction, using UL Approved Firestopping Systems.
6. Wherever conduit extends through roof, install flashings in accordance with drawings and details.
7. Be responsible for cutting and patching which may be required for the proper installation of the electrical work.

8. Protect work, materials and equipment cause whatever and provide adequate and proper storage facilities during the progress of the work.
9. Storage outdoors shall be weather protected and shall include space heaters to prevent condensation. Provide for the safety and good condition of all work until final acceptance of the work. Replace all damaged or defective work, materials and equipment before requesting final acceptance.
10. Conduit and Equipment to be Installed: Clean thoroughly to remove plaster, spattered paint, cement and dirt on both exterior and interior
11. Conduit and Equipment to be Painted: Clean conduit exposed to view in completed structure by removing plaster and dirt. Remove grease, oil and similar material from conduit and equipment by wiping with clean rags and suitable solvents in preparation for paint.
12. Items with Factory Finish: Remove cement, plaster, grease and oil, and leave surfaces, including cracks and corners, clean and polished. Touch up scratched or bare spots to match finish.
13. Site Cleaning: Remove from site all packing cartons, scrap materials and other rubbish.
14. Electrical equipment and materials exposed to public and in finished areas shall be finish-painted after installation in accordance with the Painting Section. All exposed screw-type fasteners, exterior, or interior in restrooms, shall be vandal-resistant spanner type; include tool.

L. Excavation, Cutting and Patching:

1. Excavating, trenching and backfilling required for the work of this Division in accordance with the applicable requirements of Division 2. Excavating and backfilling connected with electrical work, repaving cuts and providing and maintaining protective measures for the electrical work excavation required by the governing authorities having jurisdiction shall be performed as a part of the work of this Division.
2. Verify openings indicated on the drawings. Additional cutting, patching and reinforcement of the construction of the building as required.

M. Tests:

1. Equipment and systems for which the National Electrical Testing Association (NETA) has an approved or recommended procedure, shall be tested in accordance with that procedure. Test values shall equal values recommended by NETA. Copies of test reports shall be submitted as required under shop drawing submittals.
2. Resistance to ground tests shall be accomplished by a qualified independent testing firm to measure resistance to ground at grounding electrodes. Make tests before slabs or affected areas are poured in order that corrective measures, if required, may be taken. Submit a report showing the results of these measurements. If the resistances exceed values specified elsewhere or NETA test procedure recommendations, perform corrective measures required to reduce resistance to acceptable values.
3. Prior to energizing any motor, measure the service voltage for phase balance and report if unbalance exceeds 1% from mean.
4. Measure the three-phase voltage at no load and at maximum load conditions and submit to the report showing the results of these measurements.
5. Upon completion of the work and adjustment of all equipment, conduct an operating test. Conduct the test in the presence of an authorized representative of the Architect. Demonstrate system and equipment to operate in accordance with requirements of the Contract Documents and to be free from electrical and mechanical defects. Provide systems free from short circuits and grounds and show an insulation resistance between phase conductors and ground not less than the requirements of the governing electric code. Test circuits for proper neutral connection.

6. Complete tests prior to final inspection of project, including corrective work based on the results of the tests.
7. Perform special tests on systems and equipment as specified herein using personnel qualified to perform such tests.
8. Submit a report showing test voltage of line to neutral on the secondaries of transformers.
9. Measure voltage on secondary side of transformers with full load connected and adjust taps to provide rated secondary voltage.
10. Refer to Division 01 – Quality Requirements for other testing requirements.

N. Protection: Protect finish parts of the materials and equipment against damage during the progress of the work and until final completion and acceptance. Cover materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred. Keep moving parts clean, dry and lubricated.

O. Cleaning Up:

1. Upon completion of the work and at various time during the progress of the work, remove from the building all surplus materials, rubbish and debris resulting from the work of this Division.
2. Thoroughly clean switchgear including busses, apparatus, exposed conduit, metal work including the exterior and interior, and accessories for the work of this Division, of cement, plaster and other deleterious materials; remove grease and oil spots with cleaning solvent; carefully wipe surfaces and scrape cracks and corners clean.
3. Thoroughly polish chromium or plated work. Remove dirt and stains from lighting fixtures.
4. Leave the entire installation in a clean condition.

P. Completion:

1. The work will not be reviewed for final acceptance until operating and maintenance data, manufacturer's literature, panel directories and nameplates specified herein have been approved and properly posted or installed and final cleaning of equipment and premises has been completed.
2. When the installation is complete and adjustments have been made, operate the system for a period of one week, during which time demonstrate that systems are completed and operating in conformance with the specifications.
3. Refer to Division 01 – Execution and Closeout Requirements for other system starting requirements.

Q. Operating and Maintenance Data: Submit complete and at one time, prior to acceptance of the installation, 4 copies of manufacturer's instructions for operation and maintenance of electrical equipment, including replacement parts lists. As specified in Division 01 – Execution and Closeout Requirements.

R. Inspection and Acceptance Procedures: The Architect will submit observation reports periodically during the construction phase detailing Contract deficiencies. The Contractor is responsible for making corrections immediately. Notice of Completion of the project will not be made until all items have been corrected.

S. Substantial Completion of Electrical Systems:

1. Prior to Substantial Completion of operating electrical systems, the Contractor shall:
   a. Provide materials of the type and quality specified and as necessary for proper operation, tested and ready for use.
   b. Deliver to the Architect, the Record Drawings.

c. Furnish the required Operating and Maintenance Data/Manuals.
d. Clean up of the project pertaining to this Division of the work.
e. After installation has been completed and adjustments made, operate the system for a period of one week, during which time, demonstrate to the Architect that systems are complete and operating in conformance with Contract Documents.
f. Conduct tests required and as specified in this Division and submit test reports and corrective actions taken.
g. Submission of warranties and guarantees.

2. Substantial Completion of Work Shall be Contingent On:
   a. Contractor replacing defective materials and workmanship.
   b. Upon completion of work and adjustments made, Contractor shall conduct an operating test for each system for approval at such time as Architect directs. Conduct test in presence of authorized representative of Architect and demonstrate that systems and equipment do operate in accordance with requirements of the Contract Documents and are free from electrical and mechanical defects.
   c. Contractor shall provide the necessary training programs and instructions to the Owner's representative. Number of hours or days as required under separate Sections of these Specifications.
   d. Submit copies of manufacturer's instructions and maintenance of electrical equipment including replacement parts lists. Each set shall include one set of shop drawings of equipment installed.

T. Submittals for Change Orders: When changes are made during the construction phase, deletions and additions shall be presented in a manner that will indicate the cost of each item of material and corresponding labor. Markup shall be then added in accordance with the requirements of the General Conditions as modified by the Supplementary Conditions.

1. Unit pricing shall apply in event of changes, additions and deletions to the base Contract, as follows:
   a. Submit a unit cost, covering one hour of labor, including all applicable supervision, nonproductive labor, burdens, benefits, insurance's, taxes, direct and indirect job expenses including drawings, engineering temporary power, warehouse, tools, equipment, clean-up, bonds, overhead and profit, charged for labor. Unit cost of labor shall be applicable for duration through completion of the project.
   b. Material unit costs shall be based on the latest edition of "Electrical Trade Book," published by Trade Service Publications, Inc., Unit cost shall be taken from extreme right-hand column.

2. Labor unit quantities, for specific items as required by unit pricing and for equipment not covered by unit pricing shall be those listed in the third column from the National Electrical Contractors' Association, Inc., "NECA Manual of Labor Units."
3. For material not covered by the Unit Pricing, use the latest edition of "Electrical Trade Book, extreme right hand column. This materials cost shall remain for the duration of the contract and shall apply to all phases of construction.

U. The Contractor at a time convenient to the Owner shall provide instruction to the Owner's operating personnel in the proper operation and maintenance of the equipment and systems. The instructors shall have received factory training and shall be thoroughly familiar with the equipment installed. The operating personnel shall receive the number of days instruction as indicated in other sections.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 26 05 03

EQUIPMENT WIRING CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:

1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.02 REFERENCES

A. National Electrical Manufacturers Association:

1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.03 SUBMITTALS

A. Division 01 - Administrative Requirements: Submittal Procedures.

B. Product Data: Submit wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

C. Manufacturer's installation instructions.

1.04 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Submittal procedures.

B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.05 COORDINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements.

D. Sequence rough-in of electrical connections to coordinate with installation of equipment.

E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 CORD AND PLUGS

A. Manufacturers:

1. Hubbell.
2. Pass & Seymour.
3. General Electric.
4. Substitutions: Division 01 - Product Requirements.

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.

D. Cord Construction: Type SO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.02 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install receptacle outlet to accommodate connection with attachment plug.

E. Install cord and cap for field-supplied attachment plug.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.03 ADJUSTING

A. Division 01 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes building wire and cable; nonmetallic-sheathed cable; direct burial cable; service entrance cable; armored cable; metal clad cable; and wiring connectors and connections.

B. Related Sections:

1. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.
2. Section 31 22 00 - Grading: Execution requirements for trenching and backfill required by this section.

1.02 REFERENCES

A. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association:

1. NFPA 70 – National Electrical Code.
2. NFPA 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air Handling Spaces.

C. Underwriters Laboratories, Inc.:

1. UL 1277 – Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.03 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:

1. Solid conductor for feeders and branch circuits 10 AWG and smaller.
2. Stranded conductor for feeders and branch circuits #8 AWG and larger.
3. Stranded conductors for control circuits.
4. Conductor not smaller than 12 AWG for power and lighting circuits.
5. Conductor not smaller than 16 AWG for control circuits.
6. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
7. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

B. Wiring Methods: Provide the following wiring methods:

1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway.
4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
5. Exterior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
6. Underground Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
7. Cable Tray Locations: Use only tray cable Type TC.

1.04 DESIGN REQUIREMENTS

A. Conductor sizes are based on copper. Aluminum conductors are not permitted.

1.05 SUBMITTALS

A. Division 01 - Administrative Requirements: Submittal Procedures.

B. Product Data: Submit for building wire and each cable assembly type.

C. Test Reports: Indicate procedures and values obtained.

1.06 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and circuits.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.08 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.09 COORDINATION

A. Division 01 - Administrative Requirements: Requirements for coordination.

B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 PRODUCTS

2.01 BUILDING WIRE

A. Manufacturers:

1. Rome Cable.
2. Superior Essex.
3. Southwire.
4. General Cable.
5. Substitutions: Division 01 - Product Requirements.

B. Product Description: Single conductor insulated wire.

C. Conductor: Copper.

D. Insulation: CEC; Type THHN/THWN 600 V insulation rated 75 degrees C for feeders and branch circuits larger than 2 AWG; Type THHN/THWN 600 V insulation rated 60 degrees C for feeders and branch circuits 1 AWG and smaller.

2.02 ARMORED CABLE

A. Manufacturers:

1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Substitutions: Division 01 - Product Requirements.

B. Conductor: Copper for sizes smaller than 4 AWG.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 60 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Steel.

G. Armor Design: Interlocked metal tape.

2.03 METAL CLAD CABLE

A. Manufacturers:

1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Substitutions: Division 01 - Product Requirements.

B. Conductor: Copper for sizes smaller than 4 AWG.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 60 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Steel.

G. Armor Design: Interlocked metal tape.

H. Jacket: PVC.

2.04 TRAY CABLE

A. Manufacturers:

1. Rome Cable Company.
2. Substitutions: Division 01 - Product Requirements.

B. Product Description: Multiconductor power and control cable NFPA 70 Type TC.

C. Conductor: Copper.

D. Insulation: Flame-retardant cross-linked polyethylene.

E. Overall Jacket: Polyvinyl Chlorine (PVC) in accordance with UL 1277.

F. Insulation Voltage Rating: 600 volts.

G. Insulation Temperature Rating: 90 degrees C.

H. Listings: Finished cable UL listed as Type TC, and sunlight resistant.

2.05 WIRING CONNECTORS

A. Split Bolt Connectors:

1. ILSCO Model SK.
2. Burndy Model KSU.
3. Blackburn Model HPS.
4. Substitutions: Substitutions: Division 01 - Product Requirements.

B. Solderless Pressure Connectors:

1. ILSCO Model SLUH.
2. Burndy Model KA-U.
3. Panduit Model LAM.
4. Substitutions: Substitutions: Division 01 - Product Requirements.

C. Compression Connectors:

1. ILSCO Model CRL.
2. Burndy Model HYLUG/HYLINK.
3. Blackburn Model ATL.
4. Substitutions: Substitutions: Division 01 - Product Requirements.

2.06 TERMINATIONS

A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.

B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify interior of building has been protected from weather.

C. Verify mechanical work likely to damage wire and cable has been completed.

D. Verify raceway installation is complete and supported.

3.02 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.03 INSTALLATION

A. Route wire and cable to meet Project conditions.

B. Neatly train and lace wiring inside boxes, equipment, and panelboards.

C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

D. Special Techniques--Building Wire in Raceway:

1. Pull conductors into raceway at same time.
2. Install building wire 4 AWG and larger with pulling equipment.

E. Special Techniques - Cable:

1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

F. Special Techniques - Wiring Connections:

1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for conductor splices and taps, 6 AWG and larger.

5. Install solderless pressure connectors with insulating covers for conductor splices and taps, 8 AWG and smaller.

G. Install solid conductor for feeders and branch circuits 10 AWG and smaller.

H. Install solid conductors for branch circuits 10 AWG and smaller. However, when stranded conductors are used in lieu of solid, then install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

I. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.

J. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.

K. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

3.04 WIRE COLOR

A. General

1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
   a. Black, red, and blue for circuits at 120/208 volts single or three phase.
   b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
   a. Black, red, and blue for circuits at 120/208 volts single or three phase.
   b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase.

E. Ground Conductors:

1. For 6 AWG and smaller: Green.
2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.05 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Rod electrodes.
2. Active electrodes.
3. Wire.
4. Grounding well components.
5. Mechanical connectors.
6. Exothermic connections.

B. Related Sections:

1. Division 03 - Concrete Reinforcing: Bonding or welding bars when reinforcing steel is used for electrodes.

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers:

1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

1.03 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:

1. Metal underground water pipe.
2. Metal building frame.
3. Concrete-encased electrode.
4. Rod electrode.
5. Plate electrode.

1.04 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms maximum.

1.05 SUBMITTALS

A. Division 01 - Administrative Requirements: Submittal Procedures.

B. Product Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Manufacturer's Installation Instructions: Submit for active electrodes.

1.06 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.07 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Perform Work in accordance with CEC.

C. Maintain 2 copies of each document on site.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer Company specializing in performing work of this section with minimum 3 years documented experience.

1.09 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.11 COORDINATION

A. Division 01 - Administrative Requirements: Requirements for coordination.

B. Complete grounding and bonding of building reinforcing steel prior to concrete placement.

PART 2 PRODUCTS

2.01 ROD ELECTRODES

A. Product Description:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

B. Connector: Connector for exothermic welded connection.

2.02 ACTIVE ELECTRODES

A. Manufacturers:

1. Erico, Inc.
2. O-Z Gedney Co.
3. Thomas & Betts, Electrical.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description:

1. Material: Metallic-salt-filled copper-tube electrode.
2. Shape: As indicated on Drawings.
3. Length: 10 feet.
4. Connector: Connector for exothermic welded connection.

2.03 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 4 AWG or as noted.

C. Grounding Electrode Conductor: Copper conductor bare, size to meet CEC requirements.

D. Bonding Conductor: Copper conductor bare.

2.04 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inches NPS by 24 inches long concrete pipe with belled end.

B. Well Cover: Cast iron with legend "GROUND" embossed on cover.

2.05 MECHANICAL CONNECTORS

A. Manufacturers:

1. Erico, Inc.
2. ILSCO Corporation.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical.
5. Substitutions: Division 01 - Product Requirements.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.06 EXOTHERMIC CONNECTIONS

A. Manufacturers:

1. Copperweld, Inc.
2. ILSCO Corporation.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical.
5. Substitutions: Division 01 - Product Requirements.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.02 PREPARATION

A. Remove surface contaminants at connection points.

3.03 INSTALLATION

A. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

B. Install grounding and bonding conductors concealed from view.

C. Install grounding well pipe with cover at each rod location. Install well pipe top flush with finished grade.

D. Install grounding electrode conductor and connect to ufer grounding as indicated on Drawings.

E. Bond together metal siding not attached to grounded structure; and bond to ground.

F. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

G. Permanently attach equipment and grounding conductors prior to energizing equipment.

H. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.

I. Permanently ground entire light and power system in accordance with CEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

J. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with CEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment.

K. Ground electrical system using continuous metal raceway system enclosing circuit conductors in accordance with CEC. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

3.04 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground resistance testing in accordance with IEEE 142.

E. Perform leakage current tests in accordance with NFPA 99.

F. Perform continuity testing in accordance with IEEE 142.

G. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Conduit supports.
2. Formed steel channel.
3. Sleeves.
4. Firestopping relating to electrical work.
5. Firestopping accessories.
6. Equipment bases and supports.

B. Related Sections:

1. Division 01 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Section 27 05 29 - Hangers and Supports for Communications Systems.

1.02 REFERENCES

A. ASTM International:

1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. California Electrical Code:

1. CEC - California Electrical Code.

D. Underwriters Laboratories Inc.:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

1.03 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.04 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.

B. Firestopping Materials: ASTM E119, UL 1479, to achieve fire ratings of adjacent construction in accordance with UL Design Numbers noted on Drawings.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.05 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to CSFM and UL for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.06 SUBMITTALS

A. Division 01 - Administrative Requirements: Submittal Procedures.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:

1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

F. Manufacturer's Installation Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.07 QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire Resistant Joints in Fire Rated Roof, and Wall Assemblies: L 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on drawings for floor assembly.

E. Maintain two copies of each document on site.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum 3 years documented experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements: Environmental conditions affecting products on site.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.01 CONDUIT SUPPORTS

A. Manufacturers:

1. Allied Tube & Conduit Corp.
2. Electroline Manufacturing Company.
3. O-Z Gedney Co.
4. Substitutions: Division 01 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.02 FORMED STEEL CHANNEL

A. Manufacturers:

1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Division 01 - Product Requirements.

B. Product Description: Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

2.03 SLEEVES

A. Sleeves for Conduits Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Conduits Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Conduits Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.04 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. Substitutions: Division 01 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.05 FIRESTOPPING

A. Manufacturers:

1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products.
6. Specified Technology, Inc.
7. Substitutions: Division 01 - Product Requirements.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Multiple component foam compound.
3. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.

C. Color: As selected from manufacturer's full range of colors.

2.06 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:

1. Sheet metal.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:

1. Furnish UL listed products or products tested by independent testing laboratory.

2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing materials to arrest liquid material leakage.

D. Do not use powder actuated anchors.

E. Do not drill or cut structural members.

3.03 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:

1. Concrete Structural Elements: Provide, expansion anchors.
2. Steel Structural Elements: Provide beam clamps.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

C. Install conduit and raceway support and spacing in accordance with CEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:

1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every eight (8') feet.

3.04 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating to uniform density and texture.

D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

E. Place intumescent coating in sufficient coats to achieve rating required.

F. Fire Rated Surface:

1. Seal opening at floor, wall, partition, ceiling and roof as follows:
   a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
   b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
   c. Pack void with backing material.
   d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

2. Where cable tray, conduit, and wireway, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

G. Non-Rated Surfaces:

1. Seal opening through non-fire rated wall, partition, ceiling and roof opening as follows:
   a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
   b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
   c. Install type of firestopping material recommended by manufacturer.

2. Install escutcheons or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.
4. Interior Partitions: Seal pipe penetrations at computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetrations to completely fill annular space between sleeve and conduit.

3.05 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Division 03.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.06 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 2 inches above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install stainless steel escutcheons at finished surfaces.

3.07 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.08 CLEANING

A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.09 PROTECTION OF FINISHED WORK

A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes conduit and tubing, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:

1. Section 26 05 03 - Equipment Wiring Connections.
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
4. Section 26 05 53 - Identification for Electrical Systems.
5. Section 26 27 16 - Electrical Cabinets and Enclosures.
6. Section 26 27 26 - Wiring Devices.
7. Section 27 05 33 - Conduits and Backboxes for Communications Systems.
8. Section 27 05 36 – Cable Trays for Communications Systems.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).

B. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.03 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide thickwall nonmetallic conduit. Provide cast metal boxes.

C. Underground Within 5 feet from Foundation Wall: Provide PVC coated rigid steel conduit. Provide cast metal boxes.

D. Under Slab on Grade: Provide PVC coated rigid steel conduit. Provide cast metal boxes.

E. Outdoor Locations, Above Grade: Provide galvanized rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

F. Wet and Damp Locations: Provide rigid steel conduit. Provide cast metal outlet, junction, and pull boxes. Provide weatherproof flush mounting outlet box in finished areas.

G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.04 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.05 SUBMITTALS

A. Division 01 - Administrative Requirements: Submittal Procedures.

B. Product Data: Submit for the following:

1. Flexible metal conduit.
2. Liquidtight flexible metal conduit.
3. Nonmetallic conduit.
4. Flexible nonmetallic conduit.
5. Nonmetallic tubing.
6. Raceway fittings.
7. Conduit bodies.
8. Wireway.
9. Pull and junction boxes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.06 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents:

1. Record actual routing of conduits larger than 2 inches.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.08 COORDINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.01 METAL CONDUIT

A. Manufacturers:

1. Allied Tube.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Rigid Aluminum Conduit: ANSI C80.5.

D. Intermediate Metal Conduit (IMC): Rigid steel.

E. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.02 PVC COATED METAL CONDUIT

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devicfes.
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.
6. Substitutions: Division 01 – Product Requirements.

B. Product Description: NEMA RN 1; rigid steel conduit with external PVC coating, 20 mil thick.

C. Fittings and Conduit Bodes: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.03 FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. Allied Tube.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Interlocked aluminum construction.

C. Fittings: NEMA FB 1.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Interlocked aluminum construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.05 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel compression type.

2.06 NONMETALLIC CONDUIT

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.
6. Substitutions: Division 01 - Product Requirements.

B. Product Description: NEMA TC 2; Schedule 40.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.07 OUTLET BOXES

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.08 WIREWAY

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Raintight type wireway.

C. Knockouts: Manufacturer's standard.

D. Size: 4 x 4 inch, length as indicated on drawings.

E. Cover: Screw cover with full gaskets.

F. Connector: Flanged.

G. Fittings: Lay-in type with drip shield.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

2.09 OUTLET BOXES

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish ½ inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic: Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.10 PULL AND JUNCTION BOXES

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.
6. Substitutions: Division 01 - Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4X; flat-flanged, surface mounted junction box:

1. Material: Galvanized cast iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:

1. Material: Galvanized cast iron.
2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
3. Cover Legend: "POWER" or "SIGNAL".

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.02 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

C. Identify raceway and boxes in accordance with Section 26 05 53.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.03 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29. Provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 26 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit under slab from point-to-point.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Install fittings to accommodate expansion and deflection where raceway crosses seismic and expansion joints.

T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

V. Close ends and unused openings in wireways.

3.04 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights or as indicated on Drawings.

B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Install adjustable steel channel fasteners for hung ceiling outlet box.

L. Do not fasten boxes to ceiling support wires or other piping systems.

M. Support boxes independently of conduit.

N. Install gang box where more than one device is mounted together. Do not use sectional box.

O. Install gang box with plaster ring for single device outlets.

3.05 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 01.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.06 ADJUSTING

A. Division 01 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.07 CLEANING

A. Division 01 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Nameplates.
2. Wire markers.
3. Conduit markers.
4. Stencils.
5. Underground Warning Tape.

B. Related Sections:

1. Division 09 - Painting and Coating: Execution requirements for painting specified by this section.
2. Section 27 05 53 - Identification for Communications Systems.

1.02 SUBMITTALS

A. Division 01 - Administrative Requirements: Submittal Procedures.

B. Product Data:

1. Submit manufacturer's catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.03 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements: Environmental conditions affecting products on site.

B. Install nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

1.06 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Requirements for extra materials.

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.

B. Letter Size:

1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.

C. Minimum nameplate thickness: 1/8 inch.

2.02 WIRE MARKERS

A. Description: Split sleeve type wire markers.

B. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
2. Low Voltage Circuits: Wire number as indicated on shop drawings.

2.03 UNDERGROUND WARNING TAPE

A. Description: 4 inch wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.02 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:

1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
4. Secure nameplate to equipment front using adhesive.
5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
6. Install nameplates for the following:
   a. Switchboards.
   b. Panelboards.
   c. Transformers.
   d. Service Disconnects.

C. Wire Marker Installation:

1. Install wire marker for each conductor at panelboard gutters, pullboxes, outlet and junction boxes and each load connection.
2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
3. Install labels at data outlets identifying patch panel and port designation.

D. Underground Warning Tape Installation:

1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches minimum below finished grade or as indicated on drawings and directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 26 05 72

ACCEPTANCE TESTING

PART 1 GENERAL

1.01 SCOPE OF WORK

It is the intent of these acceptance tests to assure that all Contractor supplied equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with designed specifications.

A. The acceptance tests and inspections shall determine suitability for energization of distribution switchboards and panelboards and cables.

B. Items that shall be checked, inspected, and tested include, but are not limited to, the following:

1. Relays.
2. Power/Lighting panel boards.
3. 600V rated cable.

1.02 APPLICABLE CODES

A. All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein.

1. California Electrical Code - CEC 2004 Edition.
2. National Electrical Manufacturer's Association - NEMA.
3. American Society for Testing and Materials - ASTM.
4. Institute of Electrical and Electronic Engineers - IEEE.
5. National Electrical Testing Association - NETA.
6. American National Standards Institute - ANSI:
   a. C2, National Electrical Safety Code
   b. Z244-1, American National Standard for Personnel Protection
7. State Codes and Ordinances.
8. Insulated Cable Engineers Association - ICEA.
9. Association of Edison Illuminating Companies - AEIC.
10. Occupational Safety and Health Administration:
    a. Part 1910, Subpart S, 1910.30S
    b. Part 1926, Subpart V, 1926.950 through 1926.960
11. National Fire Protection Association - NFPA:
    a. ANSI/CECB, Electrical Equipment Maintenance
    b. CECE, Electrical Safety Requirements for Employee Workplaces
    c. ANSI/CEC, National Electrical Code 2002 Edition
    d. ANSI/NFPA 7S, Lightning Protection Code
    e. ANSI/NFPA 101, Life Safety Code
12. All inspections and tests shall utilize the following references:
    a. Project Design Specification.
    b. Project Design Drawings.
    c. Manufacturer's instruction manuals applicable to each particular apparatus.

1.03 QUALIFICATIONS OF TESTING AGENCY

A. The testing firm shall be an independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The testing firm and all the testing personnel shall have been engaged in such practices for a minimum of ten years.

D. The testing firm shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910, and 1936. Full membership in the National Electrical Testing Association constitutes proof of such criteria.

E. The lead, on site, technical person shall be currently certified by the National Electrical Testing Associate (NETA) in Electrical Power Distribution System Testing.

F. Testing firm shall utilize only full-time technicians who are regularly employed by the firm for testing services. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians may assist, but may not perform testing and/or inspection services.

G. The testing firm shall submit proof of the above qualifications.

H. The testing firm shall be an independent organization as defined by OSHA Title 29, Part 1936 and the National Electrical Testing Association.

I. All instruments used by the testing firm to evaluate electrical performance shall meet NETA's Specifications for Test Instruments. (See Section 1.7 of this specification).

J. The terms used herewith such as Test Agency, Testing Laboratory, or Contractor Test Company, shall be construed to mean testing firm.

1.04 RESPONSIBILITIES

A. The Contractor shall notify the Owners Representative prior to commencement of any testing.

B. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported.

C. The testing firm shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.

D. A stable source of 60 hertz power shall be provided for testing purposes by the Contractor. Owners Representative shall witness all tests and a minimum of 14 days notice shall be provided.

1.05 TEST EQUIPMENT

A. Test Instrument Calibration

1. The testing firm shall have a calibration program that assures that all applicable test instrumentation is maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Bureau of Standards.
3. 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 - 2 months
   c. Leased specialty equipment - 12 months (where accuracy is guaranteed by lessor)
4. Dated calibration labels shall be visible on all test equipment.
5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
6. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

1.06 TEST REPORTS

A. The test report shall include the following:

1. Summary of project.
2. Description of equipment/device tested.
3. Description of test, including date, time, and duration of test.
4. Test results.
5. Conclusions and recommendations.
6. Appendix, including appropriate test forms.
7. Identification' of test equipment used.
8. Signature of responsible test organization authority.
9. Signature of the person witnessing the tests.
10. Furnish five copies of the complete report to the Owners Representative no later than thirty (30) days after completion of project unless otherwise directed.

1.07 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:

1. Occupational Safety and Health Act of 1970 - OSHA.
2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4.
3. Applicable State safety operating procedures.
4. NETA Safety/Accident Prevention Program.
5. County's safety practices.
6. National Fire Protection Association - CECE.
7. ANSI Z244.1 American National Standards for Personnel Protection.

B. All tests shall be performed with apparatus de-energized except where otherwise specifically required.

C. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

PART 2 PRODUCTS

2.01 PROTECTIVE DEVICE COORDINATION STUDY

A. A protective coordination study shall be performed using SKM's Dapper or equal software to select or check the selection of power fuse ratings, protective relay characteristics and settings, ratios, and characteristics of associated voltage breaker trip characteristics and settings.

B. The coordination study shall include all voltage classes of equipment indicated on the single line diagram drawings. The entire electrical system shall be included in the coordination study. Verify characteristics and settings of existing devices in the field and from the manufacturer.

C. The time-current characteristics of the specified protective devices shall be plotted on the appropriate log-log paper. The plots shall include complete titles, representative one-line diagrams of both buildings and legends, associated relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves, and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, cable damage curves, symmetrical and asymmetrical fault currents. All requirements of the current California Electrical Code shall be adhered to. Reasonable coordination intervals and separation of characteristic curves shall be maintained. Separate coordination plots for phase and ground protective devices shall be provided on a system basis. Separate curves shall be used to clearly indicate the coordination achieved for feeder breakers with downstream fuses and circuit breakers in switchgear and substations. There shall be a maximum of six protective devices per plot.

D. The selection and setting of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Discrepancies, problem areas, or inadequacies shall be promptly brought to the project Owners Representative's attention.

E. Five copies of coordination curves and tabulated data indicating selection and settings of protective devices shall be submitted to the Owners Representative for approval.

PART 3 EXECUTION

3.01 EQUIPMENT VERIFICATIONS, TESTS AND CALIBRATIONS GENERAL

A. As part of the contract, the Contractor shall perform tests of installed work as herein specified and specified in other Sections of these Specifications.

B. The Contractor shall provide all materials, equipment, labor and technical supervision to perform such tests and inspections.

C. All tests shall be performed in compliance with the recommendations and requirements of the National Electrical Testing Association, Inc. (NET A), and applicable codes and standards.

D. Upon completion of the tests and inspections noted in these Specifications, a label shall be attached to all serviced devices. These labels shall indicate date serviced and the service company responsible.

E. The test and inspections shall determine suitability for continued reliable operation.

F. All tests shall be conducted in the presence of the Owners Representative. Provide a minimum of two weeks notice to the Owners Representative.

G. Furnish the necessary equipment and personnel to perform all required tests of all wiring and connections for continuity, short circuit, and improper grounds. Included, but not limited to, the following systems: substations, air interrupting switches, low voltage main and feeder circuit breakers, interlocking controls, panelboards, distribution transformers, branch circuits.

3.02 DISTRIBUTION SWITCHBOARDS AND PANELBOARDS

A. Visual and mechanical inspection:

1. Inspect for physical damage and code violations.
2. Clean interior and exterior surfaces.
3. Inspect for proper alignment, anchorage, and grounding.
4. Check tightness of accessible bolted bus joints by torque wrench method. Tighten connections in accordance with industry standard torque levels.
5. Make closure attempt on locked open devices. Make opening attempt on locked closed devices.
6. Make exchange with devices operated in off-normal positions.

B. Electrical tests:

1. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground.
2. Inspect all accessible bus joints and cable connections by infrared scanner to detect loose or high-resistance connections and other circuit anomalies.
3. Inspect correctness of control wiring.

3.03 LOW VOLTAGE CIRCUIT BREAKERS

A. Visual and mechanical inspection:

1. Inspect for physical condition.
2. Inspect alignment and grounding.
3. Perform mechanical operator and contact alignment tests on the breaker and its operating mechanism in accordance with manufacturer's instructions.
4. Perform insulation resistance test on control wiring.
5. Clean mechanism, insulating surfaces and contacts.

B. Electrical tests:

1. Measure contact resistance.
2. Trip overcurrent protective device by operation of each protective device.
3. Perform an insulation resistance test phase-to-ground, phase-to-phase and across open contacts.
4. Perform insulation resistance test in accordance with Doble procedure.
5. Perform timing test with Travel Analyzer to insure proper contact overtravel and pressure.

3.04 CABLES, LOW VOLTAGE (600 VOLTS AND LESS)

A. Visual and mechanical inspections:

1. Inspect cables for physical damage and proper connection.
2. Torque test cable connection. Tighten connections in accordance with industry standards.

3. Perform infrared scan of all connections under loaded conditions.

B. Electrical tests: Perform insulation resistance test of each cable with respect to ground and adjacent cables.

3.05 GROUNDING SYSTEMS

A. Visual and mechanical inspection: Inspect ground system connections for completeness and adequacy.

B. Electrical tests: Perform fall-of-the-potential test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or *derived* neutral points.

C. Infrared Inspection:

1. All doors and cover shall be removed and upon completion of test be reinstalled by testing agency technicians.
2. A load bank shall be furnished to circulate low *voltage* currents of 400A magnitude through each bus, main breaker and feeder breaker. After two hours infrared scans shall be made of all bus joints. Problem area shall be photographed before and after corrections. After corrections, another current test of two hours duration shall be made. Again an infrared scan shall be made to confirm correct operation.
3. Upon completion, the switchgear shall be energized at 12kV. After 4 hours, infrared scans shall be made to determine areas of *excessive* corona. Problem area shall be treated the same as under B., *above.*
4. Upon completion of infrared scans, all *covers* and doors shall be reinstalled.

END OF SECTION

SECTION 26 08 00

ELECTRICAL SYSTEMS COMMISSIONING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The purpose of this section is to define Division 26 responsibilities in the commissioning process which are being directed by the CA. Other electrical system testing is required under the direction of the PM.

B. Refer to Division 01 for additional commissioning requirements.

C. Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with 'the Contract Documents. The general commissioning requirements and coordination are detailed in Division 18. Division 26 shall be familiar with all parts of Division 18 and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to them in the Contract Documents and include the cost of commissioning in the contract price.

1.03 RESPONSIBILITIES

Electrical Contractor: The commissioning responsibilities applicable to the electrical contractor are as follows *(all references apply to commissioned equipment only):*

A. Construction and Acceptance Phases:

1. Include the cost of commissioning in the contract price, if contract not yet let.
2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, testing assistance, O&M data, training, etc.
3. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CA to facilitate the commissioning process.
4. Contractors shall provide normal cut sheets and shop drawing submittals to the CA of commissioned equipment.
5. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.
   a. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up, and checkout

      materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CA.

b. The CA may request further documentation necessary for the commissioning process.
c. This data request may be made prior to normal submittals.

6. Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, to the CA for review and approval.
7. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the Specifications, control drawings or equipment documentation are not sufficient for writing detailed testing procedures.
8. Provide assistance to the CA in preparation of the functional performance test procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
9. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists from the CA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CA for review.
10. During the start-up and initial checkout process, execute and document the electrical-related portions of the pre-functional checklists provided by the CA for all commissioned equipment.
11. Perform and clearly document all completed start-up and system operational checkout procedures, providing a copy to the CA.
12. Address current A/E punch list and Action List items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
13. Provide skilled technicians to execute starting of equipment and to assist in the functional performance tests. Ensure that they are available and present during the agreed-upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
14. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, PM and A/E and retest the equipment.
15. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
16. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (include deferred testing).
17. Provide training of the Owner's operating personnel as specified.
18. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

B. Warranty Period:

1. Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the Specifications.
2. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.04 RELATED WORK

A. Refer to Division 01 for a listing of all sections where commissioning requirements are found.

B. Refer to Division Part 1 for, systems to be commissioned.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Division 26 shall provide all test equipment necessary to fulfill the testing requirements of the Division.

B. Refer to specification Division 01 for additional Division 26 requirements.

PART 3 EXECUTION

3.01 SUBMITTALS

A. Division 26 shall provide submittal documentation relative to commissioning as required in this Section and Division 01.

3.02 START-UP PRE-FUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

A. The electrical contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 00. Division 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CA or Owner.

3.03 FUNCTIONAL PERFORMANCE TESTS

A. Refer to Division 01 for a list of systems to be commissioned and for a description of the process.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CA and PM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

3.04 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. Refer to Division 01 for specific details on non-conformance issues relating to pre-functional checklists and tests.

B. Refer to Division 01 for issues relating to functional performance tests.

3.05 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver to the *CM/GC* for inclusion in the O&M manuals. This does not replace O&M manual documentation requirements elsewhere in these Specifications

B. The CA shall receive a copy of the O&M manuals for review.

C. Refer to Division 01 for additional requirements.

D. Review and Approvals: Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CA. Refer to Division 01 for details.

3.06 TRAINING OF OWNER PERSONNEL

A. The CM/GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

B. The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

C. Electrical Contractor: The electrical contractor shall have the following training responsibilities:

1. Provide the CA with a training plan two weeks before the planned training according to the outline described in Division 01.
2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
3. Training shall include hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including start-up, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
7. Training shall include:
    a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
    b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
    c. Discuss relevant health and safety issues and concerns.
    d. Discuss warranties and guarantees.
    e. Cover common troubleshooting problems and solutions.
    f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
    g. Discuss any peculiarities of equipment installation or operation.
8. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and maintenance of all pieces of equipment.

9. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

3.07 DEFERRED TESTING

A. Refer to Division 01.

3.08 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the start-up and initial checkout plan described in Division 01 and the filled out start-up, initial checkout and pre-functional checklists.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Lighting contactors.
2. Switches.
3. Switch plates.
4. Occupancy sensors.
5. Photocells.
6. Photocell control unit.

B. Related Sections:

1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
2. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
3. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Product requirements for raceway and boxes for placement by this section.
4. Section 26 05 53 - Identification for Electrical Systems: Product requirements for electrical identification items for placement by this section.
5. Section 26 24 16 - Panelboards.
6. Section 26 27 26 - Wiring Devices: Product requirements for wiring devices for placement by this section.

1.02 REFERENCES

A. National Electrical Manufacturers Association:

1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.
5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
6. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.03 SYSTEM DESCRIPTION

A. Distributed switching control using self contained individually mounted lighting relays.

1.04 SUBMITTALS

A. Division 01 - Administrative Requirements: Submittal Procedures.

B. Shop Drawings: Indicate dimensioned drawings of lighting control system components and accessories.

1. One Line Diagram: Indicating system configuration indicating panels, number and type of switches or devices.
2. Include typical wiring diagrams for each component.

C. Product Data: Submit manufacturer's standard product data for each system component.

D. Manufacturer's Installation Instructions: Submit for each system component.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record the following information:

1. Actual locations of components and record circuiting and switching arrangements.
2. Wiring diagrams reflecting field installed conditions with identified and numbered, system components and devices.

C. Operation and Maintenance Data:

1. Submit replacement parts numbers.
2. Submit manufacturer's published installation instructions and operating instructions.
3. Recommended renewal parts list.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept components on site in manufacturer's packaging. Inspect for damage.

C. Protect components by storing in manufacturer's containers indoor protected from weather.

1.08 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five year manufacturer warranty for components.

1.09 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish twenty of each switch type.

C. Furnish twenty of each occupancy sensor type.

D. Furnish ten of each photocell type.

PART 2 PRODUCTS

2.01 LIGHTING CONTACTORS

A. Manufacturers:

1. Automatic Switch Co. Model.
2. Cutler-Hammer Model.
3. Square D Model.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: NEMA ICS 2, magnetic lighting contactor.

C. Configuration: Mechanically held, 3 wire control.

D. Coil Operating Voltage: 24 or 120 volts, 60 Hertz.

E. Poles: To match circuit configuration and control function.

F. Contact Rating: Conductor overcurrent protection, considering derating for continuous loads.

2.02 SWITCHES

A. Manufacturers:

1. Hubbell Incorporated.
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour/Legrand.
4. Substitutions: Division 01 - Product Requirements.

B. Wall Switch: Specification Grade unlighted, momentary pushbutton type for overriding relays.

1. Material: Plastic.
2. Color: White.

C. Key Switch: Spade key type. Match non-key switch ratings.

2.03 SWITCH PLATES

A. Manufacturers:

1. Hubbell Incorporated.
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour/Legrand.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Specification Grade.

1. Material: Stainless steel.
2. Color: White.

2.04 OCCUPANCY SENSOR

A. Manufacturers:

1. System Sensors.
2. Novitas.
3. Watt Stopper.
4. Substitutions: Division 01 - Product Requirements.

B. Compatible with modular relay panels. Capable of being wired directly to Class 2 wiring without auxiliary components or devices.

C. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 12 minutes.

D. Furnish with manual override.

E. Operation: Silent.

F. Room Sensors: Two-way Pattern..

2.05 PHOTOCELLS

A. Manufacturers:

1. Tork.
2. MYTECH Corporation.
3. Novitas.
4. Watt Stopper.
5. Substitutions: Division 01 - Product Requirements.

B. General: Consist of sensor mounted as indicated on Drawings with separate control-calibration module. Sensor connected to control-calibration module via single shielded conductor with maximum distance of 500 feet. Control unit powered by 24 VAC.

C. Control-Calibration Module: Furnish with the following:

1. Capable of being switched between 4 measurement ranges.
2. Separate trip points for high and low response settings.
3. Momentary contact device to override photocell relays.
4. Three minute time delay between switching outputs to avoid nuisance tripping.

D. Sensor Devices: Each sensor employs photo diode technology to allow linear response to daylight within illuminance range.

1. Exterior Lighting: Hooded sensor, horizontally mounted, employing flat lens, and working range 10-100 footcandles in 10 percent increments. Entire sensor encased in optically clear epoxy resin.
2. Indoor Lighting: Sensor with Fresnel lens providing for 60 degree cone shaped response area to monitor indoor office lighting levels.

2.06 PHOTOCELL CONTROL UNIT

A. Manufacturers:

1. Tork.
2. MYTECH Corporation.
3. Novitas.
4. Watt Stopper.
5. Substitutions: Division 01 - Product Requirements.

B. Product Description: Photodiode control unit with PHOTOCELL ENABLE and MASTER OVERRIDE inputs for remote control, 10 minute time delay, and with selectable ranges for 10-100 footcandle.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount switches, occupancy sensors, and photocells as indicated on Drawings.

B. Install wiring in accordance with Section 26 05 19.

C. Use only properly color coded, stranded wire. Install wire sizes as indicated on Drawings. Install wire in conduit in accordance with Section 26 05 33.

D. Label each low voltage wire clearly indicating connecting relay panel. Refer to Section 26 05 53.

E. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.

3.02 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Requirements for manufacturer's field services.

B. Furnish services for minimum of 7 days for check, test, and start-up. Perform the following services:

1. Check installation of panelboards.
2. Test operation of remote controlled devices.
3. Repair or replace defective components.

3.03 ADJUSTING

A. Division 01 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Test each system component after installation to verify proper operation.

C. Test contactors, and switches after installation to confirm proper operation.

D. Confirm correct loads are recorded on directory card in each panel.

3.04 DEMONSTRATION

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate operation of the following system components:

1. Operation of switches. Demonstrate for all zones.
2. Operation of each type of occupancy sensors. Demonstrate for all zones.
3. Operation of each type of photocell. Demonstrate for all zones.

C. Furnish 24 hours to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 7 days notice to Architect of training date.

END OF SECTION