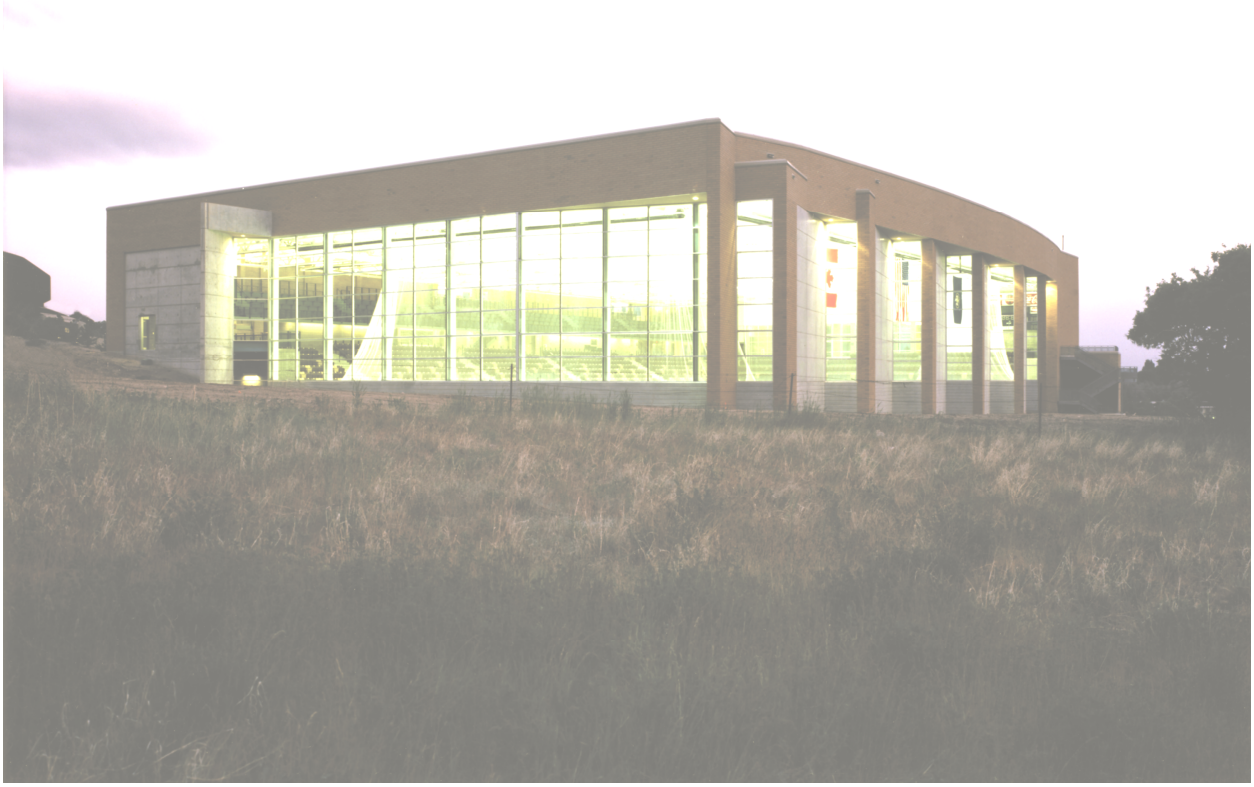
Ice Sheet Addition

4390 Harrison Blvd.
Ogden, Utah 84403



Volume 2
Construction Documents
Specifications

September 4, 2012

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ARCHITECTS

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SECTION 21 1000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:

1. Wet-pipe sprinkler systems.
2. Preaction sprinkler systems.

B. All black steel sprinkler pipe shall have a wall thickness less than or equal to schedule 40 and greater than schedule 10.

1. Exception: Pipe with a nominal pipe size of 6 inches and greater may be schedule 10.

1.3 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride plastic.

B. CR: Chlorosulfonated polyethylene synthetic rubber.

C. PE: Polyethylene plastic.

D. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

B. Preaction Single Interlock Sprinkler System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened.

1.5 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Design sprinkler piping according to the following and obtain approval from engineer, prior to submitting to other authorities having jurisdiction:

1. Design sprinkler system with the following 10% reduced flow data:

   Flow data available at Weber Ice Sheet

   Static – 73psi

   Residual – 50psi @ 1657gpm flowing

   Date of Test – 04/25/2012 by VBFA, Inc.

2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:

   a. Building Service Areas: Ordinary Hazard, Group 1.
   b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c. General Storage Areas: Ordinary Hazard, Group 1.
   d. Laundries: Ordinary Hazard, Group 1.
   e. Libraries, Except Stack Areas: Light Hazard.
   f. Library Stack Areas: Ordinary Hazard, Group 2.
   g. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   h. Office and Public Areas: Light Hazard.
   i. Residential Living Areas: Light Hazard.
   j. Restaurant Service Areas: Ordinary Hazard, Group 1.

4. Minimum Density for Automatic-Sprinkler Piping Design:

   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
   d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
   e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
   f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

5. Minimum Density for Deluge-Sprinkler Piping Design:

   a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.
   b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over entire area.
   c. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over entire area.
   d. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over entire area.
   e. Special Occupancy Hazard: As determined by authorities having jurisdiction.

6. Maximum Protection Area per Sprinkler: Per UL listing.
7. Maximum Protection Area per Sprinkler:

   a. Office Spaces: 225 sq. ft..
   b. Storage Areas: 130 sq. ft..
   c. Mechanical Equipment Rooms: 130 sq. ft..

d. Electrical Equipment Rooms: 130 sq. ft..
e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

8. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

C. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.

1.6 SUBMITTALS

A. Product Data: For the following:
1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
2. Pipe hangers and supports, including seismic restraints.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Air compressors, including electrical data.
5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
6. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable. Drawings are to be approved by Engineer prior to submission to State Fire Marshal drawings are to be submitted to FM Global prior to submission to Engineer.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction. The Engineer requires evidence to support the ability of the contractor to perform work in the scope and volume as specified. A contractor, who cannot show such experience, may be found not suitable to perform the work. The following are the approved contractors for this project:

a. PRE-APPROVED CONTRACTORS LIST
   1) Alta Fire
   2) Certified Fire
   3) Chaparral Fire
   4) Delta Fire
   5) Quality Fire Protection
   6) Fire Engineering
   7) Fire Services Inc.
   8) Simplex-Grinnell
   9) Western Automatic
   10) Western States Fire Protection

b. A contractor not listed in the “PRE-APPROVED CONTRACTORS LIST” must receive prior approval from the engineer to bid this project.

B. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET Level III technician.

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

D. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

E. International Conference of Building Code Officials codes and standards complying with the following:

1. IBC-2009, “International Building Code.”
2. IFC-2009, “International Fire Code.”

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

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

1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified. All products to be FM Global approved.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, Class 53, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

2.3 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.

1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting not allowed.

C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Central Sprinkler Corp.
3) Victaulic Co. of America.
4) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

E. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe.
5. Steel Threaded Couplings: ASTM A 865.

F. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.

1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting not allowed.

G. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

H. Grooved-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Central Sprinkler Corp.
3) Victaulic Co. of America.
4) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

I. Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 is not allowed.

J. Plain-End, Nonstandard OD, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 10 is not allowed.

K. Plain-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5 is not allowed.

L. Grooved-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5; with factory- or field-formed, roll-grooved ends are not allowed.

M. Schedule 5 Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with plain ends is not allowed.

2.4 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper; with plain ends.

1. Copper fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
2. Brazing Filler Metals: AWS A5.8, BCuP-3 or BCuP-4.

B. Plain-End, Hard Copper Tube: ASTM B 88, Type K or ASTM B 88, Type L, water tube, drawn temper.

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match tubing system.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube not allowed.
5. Brazing Filler Metals: AWS A5.8, BCuP-3 or BCuP-4.

C. Grooved-End, Hard Copper Tube: ASTM B 88, Type K or ASTM B 88, Type L, water tube, drawn temper; with factory- or field-formed, roll-grooved ends.

1. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube not allowed.
2. Grooved-Joint Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Victaulic Co. of America.

b. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting. Fittings may have ends factory or field expanded to steel-pipe OD if required for copper tube systems using grooved-end-pipe couplings.
c. Grooved-End-Tube Couplings: UL 213, rigid pattern, unless otherwise indicated; gasketed fitting equivalent to AWWA C606, but made to match copper-tube OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts. Use grooved-end-pipe couplings for tube and fitting that have expanded ends.

2.5 DIELECTRIC FITTINGS

A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.

1. Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.
c. Epco Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Industries, Inc.; Water Products Div.
f. Zurn Industries, Inc.; Wilkins Div.

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products and Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
e. Insert manufacturer's name.

E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225 deg F.

1. Manufacturers:

a. Perfection Corporation.
b. Precision Plumbing Products, Inc.
c. Victaulic Co. of America.

2.6 FLEXIBLE CONNECTORS

A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Manufacturers:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex-Pression, Ltd.
4. Flex-Weld, Inc.
5. Hyspan Precision Products, Inc.
6. Metraflex, Inc.

C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.7 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.8 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

a. Central Sprinkler Corp.
b. Fire-End and Croker Corp.
c. Viking Corp.
d. Victaulic Co. of America.

C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:

   a. Elkhart Brass Mfg. Co., Inc.
   b. Fire-End and Croker Corp.
   c. Potter-Roemer; Fire-Protection Div.

D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

   1. Manufacturers:

      a. AGF Manufacturing Co.
      b. Central Sprinkler Corp.
      c. G/J Innovations, Inc.
      d. Triple R Specialty of Ajax, Inc.

E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

   1. Manufacturers:

      a. CECA, LLC.
      b. Merit.

F. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.9 LISTED FIRE-PROTECTION VALVES

A. Valves shall be FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Ball Valves: Comply with UL 1091, except with ball instead of disc.

   1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   3. NPS 3: Ductile-iron body with grooved ends.
   4. Manufacturers:

      a. NIBCO.
      b. Victaulic Co. of America.

C. Butterfly Valves: UL 1091.

   1. NPS 2 and Smaller: Bronze body with threaded ends.

      a. Manufacturers:

         1) Global Safety Products, Inc.
         2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

a. Manufacturers:

1) Central Sprinkler Corp.
2) McWane, Inc.; Kennedy Valve Div.
3) Mueller Company.
4) NIBCO.
5) Victaulic Co. of America.

D. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:

a. American Cast Iron Pipe Co.; Waterous Co.
b. Central Sprinkler Corp.
c. Clow Valve Co.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Firematic Sprinkler Devices, Inc.
g. Globe Fire Sprinkler Corporation.
h. Grinnell Fire Protection.
i. Hammond Valve.
j. McWane, Inc.; Kennedy Valve Div.
k. Mueller Company.
l. NIBCO.
m. Potter-Roemer; Fire Protection Div.
n. Reliable Automatic Sprinkler Co., Inc.
o. Star Sprinkler Inc.
p. Stockham.
q. United Brass Works, Inc.
r. Victaulic Co. of America.
s. Watts Industries, Inc.; Water Products Div.

E. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.
4) United Brass Works, Inc.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

a. Manufacturers:

1) Clow Valve Co.
2) Crane Co.; Crane Valve Group; Crane Valves.
3) Crane Co.; Crane Valve Group; Jenkins Valves.
4) Hammond Valve.
5) Milwaukee Valve Company.
6) Mueller Company.
7) NIBCO.
8) United Brass Works, Inc.

F. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch and Visual.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

a. Manufacturers:

1) Milwaukee Valve Company.
2) NIBCO.
3) Victaulic Co. of America.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

a. Manufacturers:

1) Central Sprinkler Corp.
2) Grinnell Fire Protection.
3) McWane, Inc.; Kennedy Valve Div.
4) Milwaukee Valve Company.
5) NIBCO.
6) Victaulic Co. of America.

2.10 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.11 SPECIALTY VALVES

A. Sprinkler System Control Valves: FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

1. Manufacturers:

a. Central Sprinkler Corp.
b. Firematic Sprinkler Devices, Inc.
c. Globe Fire Sprinkler Corporation.
d. Grinnell Fire Protection.
e. Reliable Automatic Sprinkler Co., Inc.
f. Star Sprinkler Inc.
g. Victaulic Co. of America.
h. Viking Corp.

2. Deluge Valves: UL 260, cast-iron body, hydraulically operated, differential-pressure type. Include bronze seat with O-ring seals, trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.

a. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.

B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

1. Manufacturers:

a. Grinnell Fire Protection.

2.12 MANUAL CONTROL STATIONS (Pre-action)

A. Manual Control Stations: FMG approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.13 CONTROL PANELS (Pre-action)

A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and

polarized fire alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: FMG approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and a cover held closed by breakable strut.

2.14 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Manufacturers:

1. Central Sprinkler Corp.
2. Firematic Sprinkler Devices, Inc.
3. Globe Fire Sprinkler Corporation.
4. Grinnell Fire Protection.
5. Reliable Automatic Sprinkler Co., Inc.
6. Star Sprinkler Inc.
7. Victaulic Co. of America.
8. Viking Corp.

C. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.
2. UL 1626, for residential applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

1. Open Sprinklers: UL 199, without heat-responsive element.

a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.
2. Extended-coverage sprinklers, not allowed unless approved in writing prior to bidding.
3. Flush ceiling sprinklers, including escutcheon, not allowed.
4. Pendent sprinklers.
5. Pendent, dry-type sprinklers.
6. Quick-response sprinklers.
7. Recessed sprinklers, including escutcheon.
8. Sidewall sprinklers.
9. Sidewall, dry-type sprinklers.
10. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted. Finishes as approved by FM Global.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Plastic, white finish, one piece, flat.
2. Sidewall Mounting: Plastic, white finish, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.15 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm: UL 464, with 8-inch- minimum- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.

1. Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:

a. ADT Security Services, Inc.
b. Grinnell Fire Protection.
c. ITT McDonnell & Miller.
d. Potter Electric Signal Company.
e. System Sensor.
f. Viking Corp.
g. Watts Industries, Inc.; Water Products Div.

D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:

a. Grinnell Fire Protection.
b. Potter Electric Signal Company.
c. System Sensor.

d. Viking Corp.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:

a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.

F. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

2.16 PRESSURE GAGES

A. Manufacturers:

1. Brecco Corporation.
2. Dresser Equipment Group; Instrument Div.
3. Marsh Bellofram.
4. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Engineer’s Water Analysis. See Flow Analysis provided by Van Boerum & Frank Associates.

3.2 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS

A. Shop weld pipe joints where welded piping is indicated.

B. Do not use welded joints for galvanized-steel pipe.

C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

D. Underground Service-Entrance Piping: Ductile-iron, push-on or mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.

E. Sprinkler Main Piping: Use the following:

1. NPS 6 and Smaller: Standard-weight steel pipe with threaded ends, or grooved ends. No plain ends allowed.
2. Outlets shall be welded.

a. Victaulic Brand Mechanical tee fittings may be used in lieu of welded outlets.

F. Branch line piping: Use the following:

1. NPS 2 and Smaller: Threadable steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.

a. Victaulic Brand Mechanical tee fittings may be used

3.5 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13 and NFPA 14.
2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13 and NFPA 14.

a. Shutoff Duty: Use gate, ball, or butterfly valves.
b. Throttling Duty: Use globe, ball, or butterfly valves.

3.6 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping joint construction.

B. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

C. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

3.7 WATER-SUPPLY CONNECTION

A. Install shutoff Backflow preventions assemblies, valve, pressure gage’s, drain, and other accessories at connection to water service.

3.8 PIPING INSTALLATION

A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Install underground service-entrance piping according to NFPA 24 and with restrained joints.

D. Make connections between underground and above-ground piping using bolted flange.

E. Install mechanical sleeve seal at pipe penetrations in basement and foundation walls. Refer to Division 23 Section “Common Work Result for HVAC.”

F. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

G. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

H. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

I. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

J. Install sprinkler piping with drains for complete system drainage.

K. Install sprinkler zone control valves, check valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

L. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

M. Install alarm devices in piping systems.

N. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping and to NFPA 14 for standpipes.

1. No powder driven studs allowed.
2. Wrap-around braces are to be provided at end of branch lines.

O. Earthquake Protection: Install piping according to Factory Mutual 2-8 requirements, to protect from earthquake damage. Seismic Bracing shall be designed to withstand vertical forces and movement.

P. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated, or required by NFPA 13 for flexibility in seismic zones.

Q. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

3.9 SPECIALTY SPRINKLER FITTING INSTALLATION

A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.10 VALVE INSTALLATION

A. Refer to Division 23 Section "Valves" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13 and NFPA 14, manufacturer's written instructions, and authorities having jurisdiction.

B. Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

C. Double Check Valve Assemblies: Install valves in vertical or horizontal position, per listings and for proper direction of flow.

D. Deluge Valves: Install in vertical position, in proper direction flow, in main supply to deluge system.

3.11 SPRINKLER APPLICATIONS

A. General: All sprinklers are to be quick response type. Sprinkler heads shall be of the latest design closed spray type for 155°F unless specified otherwise or required by code. Extended coverage heads shall not be used. Orifices larger than 1/2" may be used as required by density and spacing demands. Use sprinklers according to the following applications:

1. Rooms without Ceilings: Upright and/or pendent sprinklers. Provide mechanical guards on all heads at or below 7’-0” height above the floor or where damage from room occupant use may occur.
2. Rooms with Ceilings: Recessed sprinklers.
3. Rooms with Ceilings: Concealed sprinklers, in gyp-board ceilings.
4. Wall Mounting: Sidewall sprinklers with recessed escutcheon.
5. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
6. Provide freeze proof type automatic sprinkler heads serving unconditioned spaces, areas subject to freezing and in other areas requiring their use.
7. Heads located within the air streams of unit heaters or other heat-emitting equipment shall be selected for proper temperature rating.
8. Sprinkler Finishes: Use sprinklers with the following finishes:

a. Upright, Pendent, and Sidewall Sprinklers: Chrome in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
b. Concealed Sprinklers: Rough brass, with White cover plate to match ceiling color.
c. Recessed Sprinklers: White, with FMG approved white escutcheon.

B. Sprinklers: Use the following:

1. All sprinklers shall be listed, quick response type.
2. Sprinkler in future finish spaces (shelled) 10’ x 10’ spacing shall be pendents/uprights installed with 1 x ½" bushing, to accommodate future finishes.
3. Finish ceiling spaces shall have recessed type escutcheon.

3.12 SPRINKLER INSTALLATION

A. Every effort shall be required to insure that the heads form a symmetrical pattern in the ceiling with the ceiling grid, lights, diffusers and grilles. Offsets shall be made in piping to accommodate ductwork in the ceiling. Heads should be symmetrical and all piping run parallel or perpendicular to building lines.

1. In no case shall sprinkler heads be installed closer than approved distances from ceiling obstructions and HVAC ductwork.
2. Sprinkler heads shall not conflict with tile grids.

3. Sprinkler heads shall be located near center of corridors.

B. Where layout of sprinkler heads is shown on reflected ceiling plans the locations shall be followed unless approval is obtained from the Architect or such locations shown do not meet the requirements of NFPA-13. In either case, approval of the Architect shall be obtained in writing before sprinkler head locations are changed. If the installation of additional heads is needed to conform to NFPA 13 requirements in areas where heads are shown on reflected ceiling plans, they shall be included in the contract price.

C. Install sprinklers in patterns indicated.

D. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

E. Future finish shelled and tenant finish; Shell spaces shall be piped to accommodate future. Install sprinklers with 1" x ½" bushings, and space heads at a maximum spacing of 100 sq. ft. per head. Occupancy shall be Ordinary-Hazard Group 1 Design.

F. Concealed type sprinkler shall be installed in hard (gyp-board) and the areas as indicated on drawings.

3.13 CONNECTIONS

A. Connect water-supply piping and sprinklers where indicated.

B. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

C. Electrical Connections: Power wiring is specified in Division 28.

D. Connect alarm devices to fire alarm.

3.14 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and in Division 23 Section "Common Work Result for HVAC."

3.15 FIELD QUALITY CONTROL

A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

B. Flush, test, and inspect standpipes according to NFPA 14, "Tests and Inspection" Chapter.

C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

D. Report test results promptly and in writing to Architect and authorities having jurisdiction.

E. Whether the underground serving the sprinkler system is done by this contractor or another, this contractor will be responsible to assure and have in his possession a certificate that the underground has been flushed and tested by the contractor who installed it in accordance with NFPA-24 prior to connection of the underground piping to the overhead sprinkler system.

3.16 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers having paint other than factory finish.

3.17 PROTECTION

A. Protect sprinklers from damage until Substantial Completion.

3.18 COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that specified tests of piping are complete and that “Material Test Certificates” are complete.

C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

E. Fill wet-pipe sprinkler piping with water.

F. Verify that hose connections are correct type and size.

G. Coordinate with fire alarm tests. Operate as required.

3.19 DEMONSTRATION & TESTS

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. All tests will be conducted as required by the local authority having jurisdiction, and in no case less than those required by NFPA standards. As a minimum, piping in the sprinkler system shall be tested at a water pressure at 200 psi for a period of not less two hours, or at 50 psi in excess of the normal pressure when the normal pressure is above 150 psi. Bracing shall be in place, and air shall be removed from the system through the hydrants and drain valves before the test pressure is applied. No apparent leaks will be permitted on interior or underground piping.

C. The local jurisdiction having authority and the Utah State Fire Marshal's office shall be notified at least three working days in advance of all tests and flushing. This includes any flushing of underground, hydrostatic testing, or flow testing that may be required.

D. This contractor shall make all the required tests to the sprinkler system as required by code. He shall be responsible to assure that the Contractor Test Certificates for the overhead, backflow and underground work are completed and delivered to the owner's insurance underwriter to assure proper insurance credit.

E. All tests requiring the witnessing by local authorities will be the responsibility of this contractor. If tests are not run or do not have the proper witness, then they will be run later and all damage caused by the system, or caused in uncovering the system for such test, will be borne by this contractor.

3.20 WARRANTY

A. This contractor shall warranty the sprinkler system and all its components for one year from the date of acceptance by the owner. Any costs incurred to extend any warranties of materials to assure this time frame shall be borne by this contractor.

B. Provide Operation and Maintenance Manuals with correct as-builts test certificates and warranties included. A minimum 6 sets to be provided in red 3-ring binders.

C. Electronic copy of AutoCAD as-built drawings shall also be provided on CD, with each O&M Manual.

3.21 FIELD QUALITY CONTROL

A. Flush, test and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

C. Report test results promptly and in writing to Architect and authorities having jurisdiction.

END OF SECTION 211000

SECTION 23 0100 - MECHANICAL REQUIREMENTS

GENERAL CONDITIONS

The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.

All sections of Division 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Section.

SCOPE OF WORK:

The project described herein is The Ice Sheet Addition at the Weber Ice Sheet in Ogden, Utah. This work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.

Section 230100 Mechanical General Requirements

Section 230150 Balancing, Maintenance Manuals, and Identification

Section 230200 Insulation

Section 230250 Seismic and Vibration Control

Section 230300 Piping Systems (Specialties and Valves)

Section 230400 Plumbing Systems

Section 230650 Ice Plant

Section 230700 Heat Transfer Systems

Section 230800 Air Distribution, Heating and Air-Conditioning

Section 230900 Automatic Temperature Control System

Section 230901 Sequence of Operations for HVAC Controls

Section 230910 Refrigeration Automation System

Section 230950 Variable Frequency Drives

SYSTEM DESCRIPTION:

Ice Arenas:	Rooftop gas fired air conditioning units DX-cooling.
Connector/Lobby:	Rooftop air conditioning unit DX-cooling, VAV with hot water reheat .
Team Rooms/Lockers	Rooftop gas fired air conditioning units DX-cooling.

Activity Areas:	Rooftop gas fired air conditioning units DX-cooling.
Ice Arena:	Rooftop gas fired air conditioning units DX-cooling.
Ice Refrigeration:	New ammonia/brine chiller, brine pumps, heat exchangers, evaporative condenser

CODES & ORDINANCES

All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will be held to complete all work necessary to meet these requirements without extra expense to the Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.

Applicable codes are as follows:

Utah Boiler and Pressure Vessel Rules and Regulations
2009 International Mechanical Code
2009 International Building Code
2009 International Plumbing Code

UTILITIES & FEES

All charges for fees and permits required by this work shall be included in the Contractor's proposal. All utility connection fees shall also be included in the proposal. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall fill ice systems with brine, shall fill refrigeration systems with refrigerant, furnish cleaners and water treatment additives.

SUBMITTALS AND SHOP DRAWINGS:

Submittals:

As soon as possible after the contract is awarded, but in no case more than 21 calendar days thereafter, the Contractor shall submit to the Architect six (6) original or high-quality copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for this project. The review of the submitted data will require a minimum of 21 days. If the Contractors schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within 14 days of returned submittals. Refer to each specification section for items requiring submittal review. Written approval of the Owner's Representative shall be obtained before installing any such equipment or materials for the project. The submittals shall be prepared in an orderly manner, contained in a 3-ring loose-leaf binder with index and identification tabs each item or group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within 60 days of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.

Submitted literature shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.

Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.

Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. In no way does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. Regardless of any items overlooked by the submittal review, the requirements of the contract drawings and specifications must be followed and are not waived or superseded in any way by the review.

By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.

ALTERNATE EQUIPMENT

Alternate equipment requires pre-bid approval.

The Contractor should protect himself with the supplier of alternate named equipment. Alternate named equipment will be reviewed only one time.

Should alternate equipment be submitted and be rejected, it shall not be resubmitted for review and it shall be the responsibility of this contractor. The contractor shall only submit on design equipment on future submittals. Incomplete submittal data will be rejected.

If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined above, the contractor shall reimburse the engineer for additional time and expenses at the engineers current, recognized, hourly rates.

DRAWINGS AND MEASUREMENTS:

Drawings:

The contract document drawings show the general design, arrangements, and extent of the system. In certain cases, the drawings may include details that show more nearly exact locations and arrangements; however, the locations, as shown diagrammatically, are to be regarded as general.

It shall be the work of this Section to make such slight alterations as may be necessary to make adjustable parts fit to fixed parts, leaving all complete and in proper shape when done. All dimensions given on the drawings shall be verified as related to this work and with the Architect's office before work is started.

This Section shall carefully study building sections, space, clearances, etc., and then provide offsets in piping or ductwork as required to accommodate the building structure without additional cost to the Owner. In any case and at any time, a change in location required by obstacles or the installation of other trades not shown on the mechanical plans shall be made without charge.

The drawings shall not be scaled for roughing in measurements nor shall they be used as shop drawings. Where drawings are required for these purposes or where drawings must be made from field measurements, the Contractor shall take the necessary measurements and prepare the drawings. Shop drawings of the various subcontractors shall be coordinated to eliminate all interferences and to provide sufficient space for the installation of all equipment, piping, ductwork, etc.

The drawings and specifications have been prepared to supplement each other and they shall be interpreted as an integral unit with items shown on one and not the other being furnished and installed as though shown and called out on both.

Coordination Drawings:

Coordinated mechanical drawings shall be provided by the Contractor for refrigeration plant area remodel to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch = 1 foot and of such detail as required to fully illustrate the work, all at the expense of this Division.
Drawings shall include all piping, conduit, valves, equipment, and ductwork. The Mechanical Contractor shall coordinate the work of all trades involved in preparation of these drawings.

Record Drawings:

Record drawings for all systems and sections of this Division shall be furnished as work of this Section. Blue-line white prints of floor plans shall be furnished by the Architect's office. These prints shall be accurately and neatly marked in colored pencil, showing all changes from schematics.
These drawings shall be reviewed with the Architect at least once each month, shall be submitted at time of final inspection, and shall be checked for accuracy. Failure to keep record drawings up-to-date shall be cause for withholding monthly payments.

CONTRACTOR'S USE OF BUILDING EQUIPMENT

The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

EXISTING CONDITIONS

The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by

new construction.

The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings unless noted otherwise. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.

The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them impossible as shown on drawings, then notification of such shall immediately be given to the Owners Representative for a decision.

EQUIPMENT CAPACITIES

Capacities shown for equipment in the specifications and on the drawings are the minimum acceptable. No equipment shall be considered as an alternate which has capacities or performance less than that of design equipment.

All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers' standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

SEISMIC REQUIREMENTS FOR EQUIPMENT

All equipment must be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

COOPERATION WITH OTHER TRADES:

The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.

The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.

The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.

The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

RESPONSIBILITY OF CONTRACTOR

The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and without expense, all

incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.

PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES

Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division.

Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

UNFIT OR DAMAGED WORK

Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

WORKMANSHIP

Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.

SAFETY REGULATION

The Contractor shall comply with all local and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.

ELECTRICAL SERVICES

Motors:

All motors required under this Division shall be furnished and installed as work of this Division. All motor-starting equipment, unless otherwise specified in Division 23 shall be furnished as work of Division 26, Electrical. Motors shall be name plated with Class F insulation as manufactured by Lincoln Electric, US Motors, General Electric, Allis Chalmers, Century, or Reliance, designed for quiet continuous operations with maximum (Class B) 90°C resistance heating rise with 40°C ambient temperature at full load and rated speed and voltage individually specified with minimum 1.15 service factor. Motors shall be all of the same make except those incorporated in packaged units. All motors shall be provided with ball bearings and conduit connection boxes. Lifting eyes shall be provided on motors 1-1/2 horsepower and larger.

The Mechanical Contractor shall furnish and set all motors, shall give the exact locations of all electrical connections, and shall provide complete information on motor control to the Electrical Contractor. The Mechanical Contractor shall be responsible for the proper operation of all electrical power equipment furnished by him.

Unless otherwise specified, motors 3/4 horsepower and larger shall be 3 phase, 60 cycle, and motors 1/2 horsepower and smaller shall be single phase, 60 cycle. Refer to fan and equipment schedules on drawings for voltage characteristics, horsepower, size, etc. All single-phase motors shall have thermal overload protection. If motor-starting equipment is included in packaged units, all three phases shall have overload protection. All motors shall have a power factor of 85 percent or better. All motors 20 horsepower and larger shall be manufacturers Premium Efficiency grade and shall meet the NEMA MG 1-12.54" efficiency ratings for energy efficient motors. All two speed motors, unless otherwise specified, shall be 1800/1200 rpm dual winding type. All 3 phase motors shall be designed and manufactured to be capable of speed control through a variable frequency drive controller. Motors shall be compatible with the furnished VFD controller.

Motors and other electrical control equipment installed in damp or moist areas or in areas of other special conditions shall be designed and approved for the installation. Motors and electrical equipment in explosive locations shall be approved for those locations. Motors located outside buildings shall be totally enclosed.

Electric Wiring:

Electric power wiring conduit, flexible conduit, outlets, relays, thermal switches, auto-off-on switches, magnetic starters, and disconnecting switches shall be provided and installed under Division 26 "Electrical Work" for all electrical equipment furnished or installed as work of this Division.

All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage shall be furnished and installed as work of this Division unless shown to be furnished by Division 26.

All such wiring shall be in conduit. Installation of any and all wiring done under Division 23 shall be in accordance with the requirements of Division 26, Electrical.
All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available and also satisfy the requirements under "Motors," as specified above.

The Mechanical Contractor must refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.

The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

WORK, MATERIALS, AND QUALITY OF EQUIPMENT

Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds and all labor shall be done in a most thorough and workmanlike manner.

Products or equipment of any of the manufacturers cited herein or any of the products approved by the

Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.

Pipe of foreign manufacture will not be acceptable.

The access to equipment shown on the drawings are the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.

All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.

All mechanics shall be capable journeymen, skilled in the work assigned to them. No one unskilled in the work which he is given to do shall be employed, and all work shall be executed in a skillful and workmanlike manner. All men employed upon this work shall be competent, faithful, orderly, and satisfactory to the Owner.

All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.

All open duct and pipe openings shall be adequately covered at all times.

INSTALLATION CHECK

An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.

All costs for this work shall be included in the prices quoted by equipment suppliers.

EQUIPMENT LUBRICATION:

The Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.

Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.

Detergent oil as used for automotive purposes shall not be used for this work.

CUTTING AND PATCHING

No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.

When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

EXCAVATION AND BACKFILLING

All necessary excavations and backfilling for the Mechanical phase of this project shall be provided as work of this Division. Work shall conform to Division for Site Work. Trenches for all underground pipelines

shall be excavated to the required depths. The bottom of trenches shall be compacted hard and graded to obtain required fall. Backfill shall be placed in horizontal layers, not exceeding 12 inches in thickness, and properly moistened. Each layer shall be compacted, by suitable equipment, to a density of not less than 95 percent as determined by ASTM D-1557. After pipelines have been tested, inspected, and approved, the trench shall be backfilled with selected material. Excess earth shall be hauled from the job site. Fill materials approved by the Architect shall be provided as work of this Division.

No trenches shall be cut near or under any footings without consultation first with the Architect's office. Any trenches or excavations more than 30 inches deep shall be tapered, shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning. This protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

The Contractor shall protect from damage all existing underground utilities or utility tunnels indicated on the contract drawings (or field located for the Contractor by the Owner prior to excavation operations). Any damage to such existing utilities or utility tunnels shall be repaired by the Contractor without additional cost to the Owner. Any damage to existing utilities not indicated on the contract drawings or designated by the Owner prior to excavating operations shall be repaired by the Contractor but shall be paid for by the Owner.

ACCESS DOORS:

Provide access doors in walls, ceilings and floors, for access to mechanical equipment such as valves, dampers, fans, controls, etc. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation. If doors are not specified in Division 8, provide the following: Doors in ceilings and wall shall be equal to JR Smith No. 4760 bonderized and painted. Doors in tile walls shall be equal to JR Smith No. 4730 chrome plated. Doors in floors shall be equal to JR Smith No. 4910.

CONCRETE BASES AND INSERTS:

Bases:

The concrete bases shall be provided and installed as work of Division 3, Concrete. This Division shall be responsible for the proper size and location of bases and shall furnish all required anchor bolts and sleeves with templates to be installed as work of Division 3, Concrete.

All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all around.

V-BELT DRIVES

V-belt drives shall be of fabric and rubber construction of approved manufacture. Multiple belts shall be matches and all belts shall be adjusted to drive the apparatus properly and to prevent slippage and undue wear in starting. Drives shall be designed for 150 percent of the specified motor nameplate rating. Belt guards shall be provided for all exposed belts and drives.

FLASHING

All pipes, ducts and roof drains which penetrate roofs or exterior walls shall be flashed and sealed watertight under this Division of the specifications. All plumbing vents shall be extended to not less than 12 inches above the roof. Roof flashings shall be furnished by this Contractor and installed by the Roofing Contractor. Flashings shall be seamless 4-pound sheet lead or of the type required by the Roofing Contractor. Flashings shall be of the size required by the Roofing Contractor and shall extend horizontally not less than 12 inches all around. The Mechanical Contractor shall furnish and install flashings for all services and shall flash and counterflash all ducts and through roofs and exterior walls.

SEALING

Pipe, conduit or duct and sleeve penetrations through fire rated floors and walls shall be sealed with Dow Corning 3-6548 Silicone RTV Foam or an approved equal. Refer to the manufacturers application guide specifications to determine proper installation procedures.

Pipe, conduit or duct and sleeve penetrations through non-fire rated floors and walls shall be sealed with Pecora butyl rubber BC-158 or an approved equal. Spaces greater than 1/4" wide must first be backed with a compressible foam backer rod and then caulked.

Pipe, conduit or duct and sleeve penetrations through below grade foundation walls shall be sealed with Vulkem polyurethane #116 or an approved equal. Spaces greater than 1/4" wide must first be backed with a compressible foam backer rod and then caulked.

After stubbing and/or caulking, all openings are to be thoroughly taped with heavy plastic or butyl duct tape to prevent sound passage.
Waterproof sleeves shall be provided on all piping penetrations through the exterior foundation walls.

CLEANING AND PAINTING

Cleaning:

After all tests and adjustments have been made and all systems pronounced satisfactory for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated members, fixture, and equipment installed under this Section and leave them ready for painting. He shall refinish any damaged finish and leave everything in proper working order. The Contractor shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere, caused by his workman or for which he is responsible. He shall remove all stickers on plumbing fixtures, do all required patching up and repair all work of others damaged by this division of the work, and leave the premises in a clean and orderly condition.

Painting

Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9, Painting. Pipe, equipment, and duct identification is work of Section 230150.
Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon completion of job. Any necessary refinishing to match original shall be done. Do not paint over nameplates, serial numbers, or other identifying marks.

Removal of Debris, Etc.:

Upon completion of this division of the work, remove all surplus material and rubbish resulting from this work, and leave the premises in a clean and orderly condition.

CONTRACT COMPLETION

Incomplete and Unacceptable Work:

If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

Maintenance Instructions:

The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists. This maintenance manual shall be furnished as work of Section 230150.

Instructions To Owner's Representatives:

In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner's representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not reduced. The ATC Contractor shall provide 20 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractor.

Guarantee:

By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subContractors as their interests may appear.
The guarantee so assumed by the Contractor and as work of this Section is as follows:

That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.

That the circulation of water shall be complete and even.

That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.

That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to

defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.

That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.

All equipment and the complete mechanical system shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period.

All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.

TEST RUN

The Mechanical Contractor shall operate the mechanical system for a minimum of 20 days to prove the operation of the system. During this test run, the Temperature Control Contractor shall provide a temperature (0 to 200 degrees F) and pressure (0 to 12 inches w.g.) recorder and record for a period of 10 days in areas so designated by the Design Engineer.

During the beginning and last day of the test run, the Temperature Control Contractor shall record the temperature settings of all room thermostats. These recordings will be included in the Operating and Maintenance Manuals.

MECHANICAL EQUIPMENT SUPPORT:

Contractor is responsible for supporting the mechanical equipment (i.e. pipes, ducts, fans, etc.) Mechanical equipment shall not be supported from the roof deck. Mechanical equipment shall be supported from the roof joists. Intermediate beams, unistruts, etc. shall be secured to the roof joists at locations approved by structural engineer. Contractor shall provide and install all materials necessary to adequately support the mechanical equipment. connection types (i.e. weldings, clips, etc.) shall be in accordance with structural engineer recommendations. Contractor shall be responsible for support sizing, locations, and types and shall coordinate with job site conditions. Contractor shall comply with structural drawings and specification.

Refrigerant Removal

The existing ice rink refrigeration system is an ammonia/brine system. This contractor shall remove all refrigerant from the system and dispose of it in a manner acceptable to all codes and local authorities. The contractor shall submit the plan for properly removing and disposing of the refrigerant in the submittal stage for review and approval. The submittal shall indicate all code authority requirements and approval processes necessary to achieve and document the complete removal. The submittal shall indicate the equipment to be used to remove (i.e. vacuum pumps) and store the refrigerant and the name and location of the disposal site. The contractor shall include in his bid all fees and costs associated with the complete removal and disposal of the refrigerant.

END OF SECTION 23 0100

SECTION 23 0150 - BALANCING, MAINTENANCE MANUALS, AND IDENTIFICATION

GENERAL CONDITIONS

All pertinent sections of Section 230100, Division 23, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

SCOPE OF WORK

This work shall include the final adjustment, balancing, and identification of all mechanical systems. The work of this section shall include but not to limited to the following.

Identification of piping, ductwork, and equipment furnished and installed as work of Division 23.

Tagging of all valves and controls furnished and installed as work of Division 23.

Balancing and adjustments of the plumbing, heating, air-conditioning, and ventilating systems furnished and installed as work of Division 23.

Supervision of start-up and commissioning of all systems and equipment furnished and installed as work of Division 23.

Submission of Operating and Maintenance Manuals complete with balancing and system commissioning reports.

Coordination of work involving other contractors essential to the final balancing of the system and supervision of the adjustments.

RELATED WORK

Installation of all materials, equipment, and controls of Division 23 is work of Sections 230100, 230150, 230200, 230250, 230300, 230400, , 230650, 230700, 230800, 230900, 230910, 230950. Rough adjustment of all systems shall be work of the section installing the work.

SUBMITTALS

Submit product data in accordance with Division 1 and Section 230100. Submit the following:

- Name and qualifications of Balancing Contractor.
- Name of certifying affiliation or certifying Professional Engineer.
- Samples of pipe, duct, and equipment identification.
- Sample test and balancing data forms.
- Sample of O & M manual outline and description of binder.
- System commissioning procedures and check list.

PRODUCTS

IDENTIFICATION

Equipment Identification

Except for individual room heating units and items furnished under Temperature Control, all items of mechanical equipment, including fans, pumps, boilers, and electrical switches and starters for mechanical equipment and gauges shall be labeled.

Information on labels shall include the following:

Identification number and name. Generally, this number and name shall be the same as that shown on the drawings or in these specifications.

If the item is a fan or pump, the flow and head shall be indicated.

If the item is part of a unit, the label shall have, in addition to its item number, the number of the main item it is serving.

Valves shall be tagged with the area served and their normal operating positions shall be indicated.

Where the main unit served by the valve is apparent, only the valve function needs to be included on the nameplate.

The types of nameplates shall be as follows:

Valve tags shall be 1/2-inch embossed aluminum tapes with identification on one side for valves. Tags for magnetic starters shall be screwed to the metal starter cover. Tags shall be Addressograph No. B-5300.

Equipment nameplates shall be black faced formica with white engraved lettering at least 3/16 inch high.

See section 230650 for further pipe and valve identification requirements.

Valve tags shall be connected to valve stems by steel rings or chains. Screws shall be used for equipment labels. Prior to installation, the contractor shall submit to the engineer a complete list of all valves and each item of equipment to be identified with the proposed identification.

Control Diagrams:

The Temperature Control Contractor shall provide a schematic control diagram on a blueline print for each separate mechanical system, including the refrigeration system, heating system, fan system, etc. Each diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, gauges, and automatic valves. The correct operating reading for each control instrument shall be marked on this diagram. A foldout copy binder of these prints shall be included in the Operating & Maintenance Manuals.
Identification of equipment on control diagrams shall correspond with the equipment nameplates furnished by the Mechanical Contractor.

OPERATING AND MAINTENANCE MANUALS

Work under this section shall be performed by the contractor performing the system testing and balancing

or by a Registered Professional Mechanical Engineer that has had previous experience in the writing of these manuals. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.

The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.

The manuals shall include Air-balancing reports, water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owners representatives.

The operating and maintenance manuals shall be as follows:

Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows:

OPERATING AND MAINTENANCE
MANUAL
FOR

THE ICE SHEET ADDITION AT THE WEBER ICE SHEET

(Year Completed)

OGDEN, UTAH

FFKR ARCHITECTS
ASSOCIATES, INC.
ARCHITECT

VAN BOERUM & FRANK
Consulting Engineers

Binders shall be a manufactured by Hiller Bookbinding.

An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall be organized as follows:

<u>SECTION I: START-UP AND OPERATION</u>

FORWARD

START-UP PROCEDURE AND OPERATION OF SYSTEM

MAINTENANCE AND LUBRICATION TABLE
AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.

SECTION 2: OPERATION AND MAINTENANCE BULLETINS

ITEM	MANUFACTURER	VENDOR	TELEPHONE

A. AUTOMATIC TEMPERATURE CONTROL

B. SPECIALIZED EQUIPMENT

C. PLUMBING AND HEATING SPECIALTIES

D. HEATING AND VENTILATING EQUIPMENT

SECTION 3: MAINTENANCE AND LUBRICATION REFERENCE TABLE

SECTION 4: AIR AND WATER SYSTEM BALANCING REPORTS

SECTION 5: EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES

SECTION 6: SYSTEM COMMISSIONING REPORTS

System commissioning report
Equipment start-up certificates

See Section 230650 for further O & M requirements

SYSTEM AIR AND WATER BALANCE

These systems shall be balanced and adjusted by person or persons fully familiar with mechanical systems of the type specified in this Division and whose main business is the balancing and adjustment of mechanical systems.

Contractors approved to do this work are Certified Testing Services, Bonneville, RS Analysis, Diamond and BTC. The balancing contractor must either be certified by NEBB, AABC, or must have all data, procedures, reports, etc. certified by a licensed Professional Mechanical Engineer actively engaged in the heating and air-conditioning field, who shall supervise the work.

The testing and balancing subcontractor shall have the necessary experienced personnel and equipment to accomplish the work. Upon request, the testing and balancing subcontractor shall furnish a list of at least (10) ten separate buildings of comparable size and system types to this project which have been balanced by this subcontractor.

Prior to commencement of the testing and balancing, the mechanical system shall be properly commissioned and ready for operation. Representatives of the equipment manufacturers shall have previously visited the project to verify that their equipment is ready for operation.

Seven (7) copies of this report shall be furnished so that one can be included in each Operating and Maintenance Manual and one copy is to be furnished to the Mechanical Engineer.

ADJUSTMENT OF AIR DISTRIBUTION SYSTEMS

The Sheet Metal Contractor shall assign the foreman or mechanic who installed the sheet-metal air-handling systems to assist in the air-balancing work.

Fresh air dampers shall be set to their minimum positions as called for in the schedules and Temperature Control Specification.

All filters shall be clean and all room doors shall be closed during the balancing procedure.

All supply and exhaust air fans shall be running.

Relief air system shall be checked for proper operation.

All dampers shall be open.

An initial volume reading of each supply fan shall be taken with a pitot tube and draft gauge.

The Contractor shall measure rpm and adjust the sheaves of all fans to handle design quantity of air. He shall check and record motor amperage. The drives shall be changed as required, at the Contractor's expense, to provide the specified air quantities.

Test and record motor full load amperes.

Supply and return fan cfm shall be checked and adjusted to verify the proper return fan tracking. Adjust supply system static pressure to provide minimum static pressure necessary at the inlet of terminal boxes.

A pressure test shall be made to verify the proper air flow from clean areas toward less clean areas.

Make a pitot tube traverse of main supply and exhaust ducts and adjust systems to obtain design CFM at fans to within 5% of design quantities.

Test and record static pressures, suction and discharge.

Test and record entering and leaving air temperatures at all fans and coils (D.B. heating and cooling, W.B. cooling), including reheat coils.

Adjust all main supply, return and exhaust air ducts to proper design CFM.

Adjust all zones to design CFM, supply, return and exhaust.

Test and adjust all terminal constant volume, variable volume, single duct, dual duct and reheat boxes. Check minimum inlet static pressure and verify proper modulation from maximum to minimum capacities.

Adjust all registers, grilles and diffusers to deliver design cfm plus or minus 10 percent of design

requirements.

All tests and readings shall include required FPM and CFM, initial FPM and CFM and final FPM and CFM after adjustments. All adjustments shall be made to minimize drafts.

The Temperature Control Contractor shall have a mechanic available to the personnel adjusting the air system for assistance in adjusting any defective control devices.

Adjustment of the Water Heating and Cooling System:

The Mechanical Contractor shall have a mechanic available to the personnel adjusting the water system for assistance in adjusting any defective control devices.
The Temperature Control Contractor shall have a mechanic available to the personnel adjusting the water system for assistance in adjusting any defective control devices.

The adjustment of the water system shall generally be as follows:

The expansion tank shall be checked for proper operation.

All automatic valves and balancing cocks shall be set to their fully open operating positions.

One pump at a time shall be started and the amperage reading checked. If the motor amperage is exceeded, the pump discharge balancing valve shall be closed as required to provide the proper amperage reading.

After the system has been purged of air and all pumps are operating, the motor amperage and the suction and discharge of all pumps shall be read and recorded.

Each pump shall be balanced for its design flow.

Venturi meters shall be read and balancing cocks on all fan coil units and coils shall be set for design flow.

Manual flow control valves on all coil units shall be adjusted. Automatic valves must be set to the fully open positions and the system water temperature must be constant. The design flow shall be set with the circuit setter.

The motor amperage and suction and discharge pressure and T.D.H. from each pump shall be read and recorded. The pump balancing valve shall be adjusted as required to give design flow.

Check, adjust and record the following items at each heating-cooling terminal heat transfer device, converter, chiller, coil, reheat coil:

Inlet and leaving water temperatures.

Pressure drop across each coil, converter, chiller evaporator and condenser.

Pressure drop across bypass valves.

All valves shall be permanently marked at their final balanced positions.

Copies of this report shall be included in the operating and maintenance manual.

The Mechanical Contractor shall clean all dirty strainers as required during the balancing procedure and shall be responsible for draining and refilling the system.

Test Run:

The Mechanical Contractor shall operate the mechanical system for a minimum of 20 days to prove the operation of the system. During this test run, this Contractor shall provide two temperature (0 - 200 degrees F) recorders and record for a period of 7 days in areas so designated by the Design Engineer. A summary of the recorded information will be included with the O & M Manuals.

Final Adjustment:

This Contractor shall be responsible for the final balancing and adjustment of all mechanical systems with necessary adjustments being made to provide a satisfactory system. If adjustments are required to produce other than conditions shown on the drawings because of job conditions, then these adjustments shall be made without extra costs.

The pressure taps, access openings, etc., necessary to balance the system, shall be installed by other Mechanical Contractors where directed by this Contractor.

The Balancing Contractor shall immediately notify the Architect, in writing, if any item of equipment, diffusers, grilles, etc., fails to operate within 5 percent of its specified capacity at the completion of the balancing of the system.

The report submitted by this contractor shall be certified to be correct by a Mechanical Engineer licensed in the State of Utah, who has originally been approved by the Architect. The reports shall be submitted to the General Contractor and he shall submit them to the Architect for review before submitting them to the Owner.

SYSTEM COMMISSIONING

This contractor shall be responsible for developing a procedure for commissioning all equipment and systems furnished and installed as part of work of Division 23. This procedure along with a check list shall be submitted to the Engineer for review. The commissioning procedure shall include a critical path chart showing the work to be performed, at which stage of construction the commissioning procedure should be performed, and the contractor who will perform the procedure. A completed check list showing all commissioning procedures, date of completion of procedure, and individuals performing procedure shall be completed and submitted to the Engineer before final inspection. Copies of the check list shall be included in the Operating and Maintenance Manuals. The following is the minimum requirements for a check list.

General Items:

Bearings Lubricated

Rotation Correct and Free
Correct Thermal Overload Protection

Shipping Restraints Removed

Equipment Secured in Place

Equipment Clean and Free of Debris

Vibration Isolators Correctly Located with Proper Springs

Motors Not Overloaded

Life Safety Items

All fire dampers checked for operation including checking reset capabilities through access doors.

All smoke alarm and fire alarm fan shutdowns.

All systems Complete Tested and Signed Off by All Appropriate Authorities

O & M Items

O & M Manuals Prepared

Pipe and Equipment Identified

Valves Tagged

Schematic Drawings Provided

Instruction of Operating Personnel

Equipment Nameplates Clean and Accessible

Piping Systems

All Service and Balancing Valves in Place and Open

Air Vents in Place

Expansion Tank Properly Located

Air Eliminator Properly Located and Piped

No Leakage

Water Treatment in Service

Thermometer Wells in Place and Properly Located

Insulation Completed

Pressure/Temperature Taps Installed

System Completely Filled and Static Pressure Proper

System Thoroughly Flushed and Clean

Start Up Strainers Removed

Permanent Strainers with Proper Sleeves

Strainer Sleeves Clean

Strainers Piped for Easy Removal of Sleeves. Service Valves in Place. No Insulation over Caps.

Dirt Pockets Installed

Flow Meters in Place. Proper Flow Direction. Gauge Tappings Turned Up. Correct Piping Length from Disturbances.

Nameplate Accessible

Pumps

Motors Aligned and Secured

Couplings Secured

Pump Bases Grouted

Flexible Connections Correct

Pressure Gauge Properly Piped

Minimum of Negative System Effect

No Entrained Air in Suction Piping to Suction Piping in an Open System

Coils

Piped Correctly. Counterflow and Water Flow Upward

Fins Combed
Provisions for Pressure and Temperature Measurement

Refrigeration Equipment

Started and Tested for Proper and Safe Operation

All Safety and Operating Controls Set and Tested

Relief Valve in Place

Crankcase Heater Energized

Oil Level Correct

No Refrigerant Leaks

Expansion Valves Properly Adjusted

System Charged

Duct System

Ductwork Clean

Access Door Tightly Closed, Gasketed with Proper Hardware

Fire Dampers and Smoke Dampers Open

Balancing Dampers in Place, Open and Locked with Accessible Operators
All Terminals in Place

Minimum Allowable Duct Leakage has been Tested and Verified

Minimum Friction and Dynamic Loss

Openings in Walls and Shafts for Air Transfer

Insulation Completed

Access doors installed

Fans

Correct V-Belt Drive Installed

V-Belt Drive Aligned

Drive Screws and Keyways Tight
Proper Belt Tension

Flexible Connection Properly Installed

Belt Guards in Place

Minimum of Negative System Effect

Filters

Clean, Specified Cells Installed

No Bypass Around Filters

Filter Gauge Installed and Calibrated

Spare Cells on Site

Automatic Control System

Control System in Operation

All Controls Installed; Piped and/or Wired

Controls Set and Calibrated

Control Sequence Verified (can be a part of Testing, Adjusting and Balancing)

Three Way Valves Properly Piped

Automatic Dampers OK

Tight Closing

Smooth Operation

Full Stroking

No Air Leaks

END OF SECTION 23 0150

SECTION 23 0200 - INSULATION

GENERAL CONDITIONS:

All pertinent sections of Section 230100, Division 23, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

SCOPE OF WORK:

This work shall include but not be limited to the installation of a complete thermal and acoustic insulation system, including the following:

Covering for all steam piping, condensate piping, hot water heating supply and return, culinary hot water, recirculating hot water and cold water piping, chilled water supply and return piping, roof drain piping, refrigerant piping and fan room, exterior duct insulation, equipment insulation, and glycol piping.

All insulation shall be installed in accordance with the recommendations of the National Insulation Contractors Association.

RELATED WORK:

Interior acoustical duct lining is specified in Section 230800, Air Distribution, Heating and Air-Conditioning. Pipe hangers and pipe shields are specified in section 230300.

Ice refrigeration plant insulation requirements are specified in Section 230650.

SUBMITTALS

Submit product data in accordance with Division 1 and Section 230100. Submit the following:

Pipe Insulation
Duct Insulation
Equipment Insulation
Cements and Finishes
Application Procedures

Field Model

Construct a field model to show a finished sample of each type of insulation to be installed on the project. Model shall be used to show material installation and finishes for piping, ductwork, and equipment including applications at hangers, supports, flanges, valves, etc. Model shall also be used as a reference to establish quality of workmanship.

MATERIALS:

Approved Manufacturers

Fiberglass insulation shall meet the requirements of ASTM C 547 as manufactured by Manville, Certain-Teed, KNAUF, or Owens-Corning. Calcium silicate insulation shall meet the requirements of ASTM C 533, as manufactured by Manville, Owens-Corning, or Pabco.

Flexible unicellular insulation shall meet the requirements of ASTM C 534, as manufactured by IMCOA/IMCOLOCK, IMCOA/IMCOSHIELD, Armstrong, Halstead, or Armaflex.

Smoke Burning Characteristics:

Insulation materials, adhesives, coatings and other accessories shall have burning characteristics as determined by ASTM E 84 and tested with UBC Standard 42-1 shall have a flame spread and smoke contribution as follows:

A. All batting insulation shall have a flame spread of 0 to 25 and a smoke contribution of 0 to 50.

B. All foam plastic insulation shall have a flame spread of 0 to 75 and a smoke contribution of 0 to 50.

C. Pipe and tubing insulation shall have a flame spread of 0 to 25 and a smoke contribution of 0 to 50.

D. Duct insulation shall have a flame spread of 0 to 25 and a smoke contribution of 0 to 50.

Insulation Thickness:

Insulation thicknesses in Table A are based on insulation having thermal resistivity in the range of 4.0 to 4.6 hr. ^{o}F square foot/Btu per inch of thickness on a flat surface at a mean temperature of 75°F.

TABLE 'A' - MINIMUM PIPE INSULATION

INSULATION THICKNESS IN INCHES FOR *1 PIPE SIZES *2

PIPING SYSTEMS TYPES	RANGE TEMPERATURE UP TO ^{o}F	RUN-OUTS AND 2" *1	8" 1" TO LESS	l-1/4" TO 2"	2-1/2" TO 4"	5" LAR-6"	AND GER
HEATING SYSTEMS							
Low temperature	120-200	1/2	1	1	1-1/2	1-1/2	1-1/2

For the purposes of the following Table A the following fluid temperatures and pressures are to be used unless specified otherwise:

Domestic hot water is	140 ^{o}F
Recirculating domestic hot is	110 ^{o}F

Hot Water Supply and Return:

Hot water supply and return piping shall be insulated with Owens-Corning ASJ-25 fiberglass pipe insulation with vapor seal jacket. See Table A for thickness of insulation. The insulation shall be applied over clean, dry pipe with all joints firmly butted together. Fittings shall be similarly insulated with a fiberglass blanket insulation covered with a premolded PVC cover. Provide an aluminum fitting cover where pipe is covered with an aluminum jacket.

Domestic Water:

All domestic hot water and cold water piping shall be covered with Owens-Corning ASJ-25 fiberglass pipe insulation with vapor seal jacket. Insulation thickness shall be 1/2-inch for all cold water piping. See Table A for thickness of insulation for hot water piping. Insulation thickness for all recirculating hot water shall be the same thickness as shown in Table A for domestic hot water lines. Fittings shall be similarly insulated with a fiberglass blanket insulation covered with a premolded PVC cover.

Roof Drainage Lines:

All piping above grade shall be insulated with 1/2-inch thick Owens-Corning ASJ-25 fiberglass pipe insulation with vapor barrier jacket. The insulation shall be applied over clean, dry pipe with all joints firmly butted together. Fittings shall be similarly insulated with a fiberglass blanket insulation covered with a premolded PVC cover. Cover to be sealed to vapor seal jacket on piping. Provide an aluminum fitting cover where pipe is covered with an aluminum jacket. All rain leader bowls shall be insulated with fiberglass insulation with a field applied vapor barrier jacket consisting of fiberglass reinforced cloth and finished with insulating cement to form a smooth surface.

Duct Wrap Insulation:

Duct wrap shall be Owens-Corning Fiberglass FRIL type IV Ductwrap, 1-1/2" thick, with vapor barrier foil reinforced kraft facing overlapped 2" at joints. All round ducts are to be wrapped except where exposed.

Insulation shall be wrapped tightly on the duct with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches. Insulation shall be adhered to metal with 4-inch strips of insulation bonding adhesive at 8 inches o.c. and taped with foil-reinforced kraft tape not less than 3 inches wide. the same method shall be used for longitudinal joints,. All pin penetrations or punctures in facing shall also be taped. All joints shall be covered with foil-reinforced kraft tape 3 inches wide.

GENERAL REQUIREMENTS:

All insulation shall be installed in accordance with the recommendations of the Manufacturer and National Insulation Contractors Association, MICA.

Pipe Insulation:

Prior to application of insulating materials, surfaces to be insulated shall be brushed clean and made free from rust, scale, grease, dirt, and other deleterious materials. Insulation shall be installed to facilitate removal for making repairs. Insulation sections or blocks shall be placed so the least possible damage to insulation will result from inspection or repair of piping or equipment to which it is applied.

Wherever a leak from a valve or other source might drip onto an insulated surface, the surface shall be protected with 22-gauge aluminum band rolled up at the ends and large enough to prevent dripping or splashing on surrounding areas.

See Section 230300 for insulated protective hangers supplied and installed by the Mechanical Contractor. For all insulated piping not installed with pre-insulated pipe supports, this contractor shall install high density inserts (calcium silicate) as shown in detail A on Plate No. 6 of MICA insulation standards at each pipe support or hanger. Provide metal shield under hanger. On hot pipe, apply three-inch wide vapor barrier type or band over the butt joints between pipe insulation and pre-insulated hanger. On cold water, chiller water or other cold fluid piping, apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum of three-inch wide vapor barrier tape or band.

Insofar as possible, pipe insulation shall be applied in sectional form. When segmental form is used, segments shall be fit to curved surfaces to which they are applied. All joints shall be carefully pointed with cement. A thin finishing coat of insulating cement and OCF fitting mastic shall be applied on segmental forms of covering to present a smooth, even surface. Calcium silicate insulation shall be installed in staggered pattern and shall be wired in place at 9 inches on center with 16 ga wire.

All piping exposed to the weather shall be covered with a 0.024 thick embossed aluminum jacket pop-riveted and banded at 12 inches on center. All joints shall be caulked and sealed watertight with a suitable silicone sealant. All seams shall be located on the bottom of the pipe away from the weather. Insulation shall not be applied over flanged joints until piping has been brought up to operating temperature and flange bolts have been fully tightened.

For all hot and non-cold fluid systems, insulation shall be beveled to expose all flanges, unions, valves, strainers and special accessories. Raw ends of insulation shall covered with finishing cement to provide a smooth water proof surface.

For all chilled water, cold water and cold fluid systems, all flanges, valves, control valves, and special accessories including pumps shall be insulated with covering equal in temperature resistance and thickness to that of connecting piping. A short piece of covering shall be installed next to flanges on both sides of joints so that this piece can be removed and the bolts taken out of the joint without disturbing the covering on the remainder of the line. Covers for all flanges, unions, valves, and special accessories shall be constructed in two halves. Provide a two piece removable insulated box for chilled water pumps. Insulation shall be of the equivalent thickness as for the piping system and shall be covered with a matching PVC or aluminum jacket.

Testing and Approval:

No pipe insulation shall be applied until the piping has been pressure checked and approved. No duct insulation shall be applied until the ducts have been inspected and approved. All insulation shall be applied strictly in accordance with manufacturer's recommendations.

END OF SECTION 23 0200

SECTION 230250 - SEISMIC AND VIBRATION CONTROL

GENERAL CONDITIONS:

All pertinent sections of Section 230100, Division 23, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

SCOPE OF WORK:

The scope of work shall include all labor, material, and equipment necessary for a complete anchorage and seismic restraint system and vibration isolation system for all work included as part of Division 23. The system design and installation shall be based on Seismic Zone III of the Uniform Building Code, and other standards listed below.

The work shall include all new mechanical isolated and non-isolated equipment, ducts and piping systems which shall include:

1. Water heaters/tanks
2. Expansion tanks
3. Pumps
4. Rectangular and oval ductwork 6 sq. ft. in cross-sectioned area and larger
5. All piping 2-1/2" dia and larger except waste, vent and roof drainage piping

REFERENCE STANDARDS:

1. International Building Code
2. NFPA Bulletin 90A, Current Edition
3. UL Standard 181
4. Tri-Services Manual, Fagel Et Al, 1973
5. SMACNA Guidelines for Seismic Restraints of Mechanical Systems
6. ASHRAE - American Society of Heating, Ventilating and Air Conditioning Engineers.

SUBMITTALS:

Submit product data in accordance with Division 1 and section 230100. Submit the following:

Restraint system and anchorage method to be used for each piece of equipment.

Shop drawings showing size, hanger length, and the location of all seismic restraints for piping and ductwork.

Seismic restraints and calculations for all flexible mounted equipment.

Vibration isolators and flexible couplings.

Details for all the isolators and seismic bracing with snubbers proposed for items in this specification and on the Drawings.

Details for steel frames, concrete inertia bases, and anchors to be used in conjunction with the isolation of the items in this specification and drawings.

Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors and snubbers.

SEISMIC REQUIREMENTS AND QUALIFICATIONS:

The Mechanical Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the International Building Code.

All supports, hangers, bases, braces and anchorage for all non-isolated equipment, ductwork and piping shall be installed as detailed and specified in the contract documents. Specific requirements on equipment anchorage and restraints, locations and sizes shall be furnished by the contractor and submitted to the Project Engineer for review after shop drawings for mechanical equipment have been reviewed.

All supports, hangers, bases, anchorage and bracing for all isolated equipment shall be designed by a professional engineer employed by the restraint manufacturer, qualified with seismic experience in bracing for mechanical equipment. Shop drawings submitted for earthquake bracing and anchors shall bear the Engineer's signed professional seal.

The Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases designed to receive seismic bracing and/or anchorage. All isolated mechanical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings certified correct by the equipment manufacturer for Seismic Zone the project is located in.

Manufacturers and suppliers of restraint equipment and systems approved for use by the Contractor, for isolated and non-isolated systems, are Mason Industries, Inc., Korfund, Amber/Booth Company, Vibration Mountings & Control Co. Manufacturer of seismic restraint equipment and the vibration isolators for isolated equipment shall be the same manufacturer.

Manufacturers representative shall inspect the project and provide a report once everything is properly seismically restrained. A copy of the report shall be submitted to the engineer and a copy shall be placed in the O&M manuals.

SPECIAL SOUND QUIETING:

The seismic and vibration control manufacturer shall analyze the operating conditions and make recommendations for any modifications and additions to the Owner's Representative.

SEISMIC REQUIREMENTS:

All mechanical equipment, piping and ductwork shall be braced, snubbed or supported to withstand seismic disturbances and remain operational. Furnish all engineering, labor, materials and equipment to provide protection against seismic disturbances as specified herein.

Isolated Equipment:

All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration isolation section of this specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. The snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials.

Elastomeric material shall be replaceable and a minimum of 3/4" thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more than 1/4". Snubbers shall be installed with factory set clearances. Snubbers shall be equal to Mason Z-1011.

A one "g" minimum vertical and lateral level shall be used in the design of all snubbers restraining isolated equipment.

Piping:

All isolated and non-isolated piping 2-1/2" I.D. and larger shall be protected in all planes by restraints to accommodate thermal movement as well as restrain seismic motion. Locations shall be as scheduled and shall include but not be limited to:

a. At all drops to equipment and at flexible connections.

b. At all 45° or greater changes in direction of pipe.

c. At horizontal runs of pipe, not to exceed 30 feet O.C. spacing.

d. Piping shall be restrained by a cable restraining system using a minimum of two cables at all restraint points.

e. Shop drawings shall be submitted with the locations of all restraints shown on a floor plan and noting the size and type of restraint to be used.

f. Gas piping shall have additional restraints as scheduled.

Non-Isolated Equipment:

The restraint systems for all non-isolated equipment shall be designed according to Table 23P, sec. 2312 of the Uniform Building Code with an importance factor of 1.5, a site factor Z = 0.75 and a Cp = 0.3. Horizontal force factor for elements of structures. In addition, the vertical forces restraint requirement shall be computed as 1/2 the value of the horizontal forces. All equipment not anchored directly to floors shall be restrained by cables as designed and furnished by the Restraint Manufacturer.

All piping and ductwork shall be installed to prevent transmission of noise and vibration into the structure.

END OF SECTION 23 0250

SECTION 23 0300 - PIPING SYSTEMS, SPECIALTIES AND VALVES

GENERAL CONDITIONS:

All pertinent sections of Section 230100, Division 23, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

SCOPE OF WORK:

This work includes furnishing all labor and materials to complete all piping systems including piping specialties and valves for the HVAC and plumbing systems.

RELATED WORK:

Refer to Section 230100, 230400, 230650, and 230700 for piping system tests. Refer to Section 230150 for pipe identification. Refer to Section 230200 for pipe insulation. Refer to Section 230650 for brine and ammonia piping.

SUBMITTALS:

Submit product data in accordance with Division 1 and Section 230100. Submit the following:

Pipe, couplings, and fittings
Valves
Hangers and insulated pipe supports
Specialty Items

PIPE AND FITTINGS:

NO PIPE OF A FOREIGN MANUFACTURER WILL BE ACCEPTABLE.

All piping, fittings, flanges, etc. shall be free from defects and shall comply with the appropriate ASTM specifications.

Black and Galvanized Steel Pipe: ASTM A53 ERW Grade B, Standard Weight (Schedule 40) or Extra Strong (Schedule 80) as specified.

Copper Tubing: ASTM B88, Type L or K as specified.

Cast Iron Soil Pipe and Fittings: ASTM A74

Welded Black Steel Fittings: ASTM A234 Grade B, 150-pound for Standard Weight Piping, 300-pound for Extra Strong Piping, or of weight or Schedule of matching piping.

Threaded Malleable Iron Fittings: ANSI B16.3, 150-pound for Standard Weight Piping, 300-pound for Extra Strong Piping, or of weight or Schedule of matching piping either black or galvanized to match piping.
Welded Flanges: ASTM A181 Grade B, 150-pound for Standard Weight Piping, 300-pound for Extra Strong Piping or of equal weight of connected equipment.
Copper Fittings: Wrought Copper, ANSI specification B16.22.

Drains for drip pans shall be Type L hard copper tubing with wrought-copper fittings. A P-trap shall be provided at drain pans. Drains from all drip pans shall be run to floor drains.

Gas piping in the building and not buried shall be standard weight black steel pipe and shall have welded fittings.

Domestic hot water, hot water return, and cold water piping shall be type L or K hard tempered copper pipe with wrought-copper fittings using 95-5 solder. Standard weight galvanized steel pipe with galvanized malleable iron screwed fittings or mechanical grooved galvanized iron fittings may be used in lieu of copper on sizes 3-inches and larger.

Domestic hot and cold water piping buried below grade shall be Type K soft tempered (annealed) copper without fittings or joints and covered with IMCOA Imcoshield unicellular insulation.

Soil, waste and vent lines 2" and larger inside building shall be standard weight cast iron. Lines smaller than 2" shall be standard weight galvanized steel pipe with drainage type fittings. All soil, waste, and vent piping below ground shall be hub and spigot standard weight cast iron with Ty-Seal neoprene gaskets or Tyler No-Hub with high torque clamp all stainless steel couplings and neoprene gaskets.
.
Waste and vent joints for cast-iron waste and vent piping above ground shall be Ty-Seal neoprene gaskets or Tyler No-Hub with high torque Clamp-All stainless steel couplings and neoprene gaskets.

Heating hot water supply and return piping shall be Standard Weight black steel pipe or type L or K hard tempered copper pipe with wrought-copper fittings. Steel pipe 2-1/2 inch and larger shall either have welding or mechanically grooved fittings. Steel pipe 2-inch and smaller shall either have welding fittings, mechanically grooved fittings or malleable iron screwed fittings.

PIPE COUPLINGS:

Insulating Fittings:

Dielectric unions or couplings as manufactured by Walter Vallet Company, Victaulic or Central Sprink, Inc. shall be installed to connect dissimilar metals (such as steel and copper) to prevent electrolytic action.

VALVES AND COCKS:

Nameplate or markings on each valve shall show manufacturer or trademark, size, grade, and pressure-temperature service rating.

Unless otherwise specified, all valves in connection with piping shall be Hammond, Milwaukee, Keystone, Crane, Centerline, Walworth, NIBCO, Stockam, Watts, Central Sprink, Inc. or Grinnell. Ball valves shall be bronze with bronze ball, teflon seat, indicator dial, insulated handle, and adjustable packing. Gate or butterfly valves shall be used on all water piping 2-1/2 inches and larger. Ball or globe valves may be used on all water piping 2 inches and smaller. Exceptions, if any, are shown on the plans or noted in specific sections of the specifications. All valves 2 inches and smaller shall be all bronze construction. Companion flanges shall be provided for butterfly screwed connections. Companion flanges shall be provided for butterfly valves and nonslam check valves. Valves, except where noted in specific sections, shall be rated for a minimum of 125-psi steam working pressure at 353 degrees F.

Valves locations are either shown or noted on plans; generally, however, any valve inadvertently omitted, or customarily furnished, or necessary for the proper maintenance and operation of this system shall be furnished as work of this Division.

Valves shall be installed with stems horizontal or above. Where possible, valves shall be located for operation from floors or platforms. Chain wheels or valve extensions shall be provided where valves are more than 11 feet above floors or platforms. Glands shall be tightened and gland packing added as required.

Nonslam check valves shall be used in the discharge lines from all pumps, except in-line pumps.

The following valves are used for design and descriptive purposes and to establish a standard of quality:

Gate valves 2 inches and smaller shall be Milwaukee 1151 or 1169; Grinnell 3080 or 3080SJ; NIBCO #T-134 or S-134.

Gate valves 2-1/2 inches and larger shall be Milwaukee F-2885-M; Grinnell 6020A; Crane 465-1/2; NIBCO #F-617-O.

Globe valves 2 inches and smaller shall be Milwaukee 590-T or 1590-T; Crane No. 7 or No. 1310; NIBCO #S-235-Y or T-235-Y; Grinnell 3240 or 3240SJ.

Globe valves 2-1/2 and larger shall be Milwaukee F-2981-M; Crane 350 or 351; NIBCO #T-718-B or F-718-B; Grinnell 6200A.

Calibrated balancing valves 2 inches and smaller shall be Bell & Gossett Circuit Setter, equipped with Barco shutoff valves and quick-disconnects.

Check valves 2 inches and smaller shall be Milwaukee 509 or 1509; Crane No. 36 or No. 1342; NIBCO #T413-B or S-413-B; Grinnell 3300 or 3300SJ.

Check valves 2-1/2 inches and larger shall be Milwaukee F-2974-M; Crane No. 373 or 374; NIBCO #F-918-B; Grinnell 6300A. Nonslam check valves shall be Mission Duo-Check 60SVF or Watts F-ICU-125 or Central Sprink, Inc.

Butterfly valve 2" and smaller shall be Milwaukee Butterball BB2-100 or BB2-350.
Butterfly valves 2-1/2" and larger shall be lug type Milwaukee ML-223-E for 5" and below or Milwaukee ML-323-E for 6" and above rated bubble-tight dead end service at full 200 psi working pressure or Central Sprink, Inc. grooved at 300 psi.

Ball valves shall be Milwaukee BA-100 full ported two-piece construction, or Milwaukee BA-300 full ported three piece construction or Watts B-6000.

Balancing cocks 2 inches and smaller shall be Crane No. 250 or Milwaukee Butterball BB2-100 or BB2-350 with memory stop.

Gas valves 1-1/4 inches and smaller shall be Crane No. 250 square head or Milwaukee Butterball BB2-100.

Air vent valves shall be Crane No. 88 or Milwaukee 600, 200-psi

working pressure, 3/8 inch bronze needle-point globe.
Valve assemblies by Flowset may be used where approved.

SPECIALTIES:

Pressure Gauges:

The Contractor shall furnish and install U.S. Gauge Series 5001, Trerice, Marsh, Marshalltown, or Ashcroft, 3-1/2 inch dial or as noted on the drawings, black cast-aluminum pressure gauges and chrome-plated ring. All gauges shall be provided with a shutoff cock and snubber. Each gauge shall be of the free-standing repairable type, with graduations and scale suitable for the pressure encountered. Compound gauges shall be installed where necessary. A list of all gauges with graduations, type, and locations shall be submitted to the Engineer for approval before any gauge is installed.

Strainers:

Strainers shall be Keckley, Sarco, Victaulic, Central Sprink, Inc. or Webster, of the self-cleaning type. Perforations in strainers shall be 1/16 inch in diameter. Blowoff ball valves with shall be provided for all strainers. A threaded hose connection shall be provided on all strainers located above ceilings. The outlet of all other strainer blowoff shall be piped to above floor in a location adjacent to a wall or so that traffic or accessibility to equipment is not restricted and so that any item or piece of equipment is not damaged. Pressure rating of strainers shall be equal to but in no case less than the pressure testing of adjoining valves.

Thermometers and Test Wells:

Where indicated on the drawings and the water piping diagrams, thermometers as manufactured by the Moeller Instruments Co., Weksler, Palmer, Weiss, or approved equal shall be installed. Thermometers shall be provided with glass red reading column, mercury filled, 9-inch scale, V-shaped, straight, angular, or inclined pattern as required by conditions under which they are to be installed and as required for proper reading. Thermometers shall be provided with expansion heads as required by their location in the piping system. Thermometers shall be provided with expansion heads as required so that they will not break under extremes of temperature. Each thermometer shall be provided with a separable socket well which shall be placed in the piping system. The well and stems of thermometers shall be the length required for accurate reading of the thermometer. Where thermometers occur in the insulated piping systems or on installed equipment, extension necks shall be provided so that the thermometer casing is outside of the insulation. Thermometer test wells equal to Moeller bar stock test well with plug and chain will be installed in outlet water connection to each cooling coil, and from the outlets of all heating coils in the main air-handling unit equipment rooms, so that the water flow may be properly balanced. Thermometers shall be calibrated at mid-range of scale before they are installed.

Combination Pressure Temperature Test Wells:

Where indicated on the drawings, combination test plugs by Universal Control or Taco shall be installed. Two sets of pressure gauges and thermometers for use by the building maintenance staff shall be provided.

PIPE HANGERS AND SUPPORTS:

All necessary structural members, hangers, and supports of approved design shall be provided to keep piping in proper alignment and to prevent transmission of injurious thrusts and vibrations. Pipe hangers shall generally be of the clevis pipe-clamp type with suspension bolts. All bolts shall have provision for vertical adjustment and shall be equipped with locknuts. Where concrete inserts are used, they shall be suitably reinforced. The Contractor shall obtain approval of the Architect for the location of such inserts prior to their installation. Pipe supports in tunnels shall be roller type with protective saddles. Spring and spring roller hangers shall be used wherever vertical movement of pipe occurs so that pipe and pipe supports shall always be in absolute contact. Expansion shields may be used provided that the hanger is not attached rigidly to the expansion bolt, but is supported from a suitable bracket held in place by expansion bolts. No hanger shall be welded directly to steel joists. Where joists occur, clips shall be installed and hanger rod attached to clips. All piping hung from joists shall be hung from joist panel points. Protective saddles shall be provided on all insulated piping at point of hanger. Hangers shall not contact pipe where pipe is specified to be insulated and hangers shall not penetrate insulation.

The following is a schedule of maximum spacing for hangers or other supports and sizes of suspension rods for piping. In addition to the spacing listed, an additional hanger shall be provided 1 foot 0 inches from each pipe drop, rise, or turn.

Pipe Size	Rod Diameter	Maximum Spacing
1-1/4 in. and smaller	1/2 in.	6 ft.
1-1/2 in. and 2 in.	1/2 in.	9 ft.
2-1/2 in. and 3 in.	5/8 in.	10 ft.
4 in. and 6 in.	3/4 in.	10 ft.
8 in. and 10 in.	7/8 in.	10 ft.
12 in. and 814 in.	1 in.	10 ft.

Pipes larger than 3 inches in diameter must be hung from beams. Where beam spacing is greater than a 10 foot 0 inch span for pipes, intermediate beams must be installed to support pipes. Groups of pipes anchored to floor slabs shall not exceed a 300-pound load between beams. Intermediate beams shall be provided to support pipes if a 300-pound load is exceeded.

Pipes larger than 3 inches which must be supported from roof joists shall be hung from every joist (max. 7'-0" o.c.). the hangers shall be within 3 inches of panel points or the mechanical Contractor shall add a brace to the joist as per the structural general notes or as directed by the architect.

Pipe hangers shall not be welded to metal pan floor. Pipe hangers shall be concrete inserts installed in holes drilled in concrete.

All hangers, supports, and anchors shall be assembled with heavy pattern, hexagon carbon steel nuts.

Perforated metal strap shall not be permitted.
Pipes above ceilings are to be grouped together and either hung from individual rod hangers or on Unistrut trapeze hangers as shown on the drawings. Pipes are to be run as high as possible for maximum clearance of attic spaces.

Risers shall be properly supported and guided at each floor. Pipe hangers, inserts, rollers, etc., and all necessary accessories required to support piping shall be provided by the Contractor, unless noted otherwise.

The Contractor shall install all the metal supports in the tunnels and equipment rooms to form a pipe rack as detailed on the plans. All hot water piping, steam, and condensate return installed on the pipe racks are to be installed on pipe saddles and cast iron rollers. All other piping installed on racks is to be provided with metal saddles and U-bolt guide supports and supported from the metal frame of the rack. High-pressure steam expansion loops are to be hung from tunnel ceiling with double rod hangers with rollers.

All soil, waste, and vent stacks shall be substantially supported at the base with either a base stack fitting and concrete block or a riser clamp resting on the floor slab.

All pipe hangers, inserts, trapezes, etc., and all necessary accessories required to support the piping shall be provided by this Contractor.

All pipe hangers shall be installed outside of insulation on all insulated lines.

Manufacturers may be Blaw-Knox, Grinnell, or Pipe Shields, Inc.

Insulated Pipe Supports:

Insulated pipe supports shall be furnished and installed by the Mechanical Contractor on all insulated pipe and tubing according to the following tables. See Pipe Insulation Specification Section. Supports shall be Pipe Shields, Inc. All designations as to hanger type refer to Pipe Shields, Inc., model numbers.

Horizontal Pipes:

Model Designations

Pipe Size	Maximum Horizontal Spacing	In Ring Or Clevis Hanger		On Flat SurfaceRoll		On Pipe	
		Cold	Hot	Cold	Hot	Cold	Hot
Through 1-1/4"	7'-0	CS-CW	CS	CS-CW	CS	CSX-CW	CSX
1-1/2	9'-0	CS-CW	CS	CS-CW	CS	CSX-CW	CSX
2 - 4	10'-0	CS-CW	CS	CS-CW	CS	CSX-CW	CSX
6	10'-0	CS-CW	CS	CS-CW	CS	CSXP-CW	CSXP
8	10'-0	CS-CW	CS	CSXP-CW	CSXP	MXP	MXP
10-16	10'-0	CS-CW	CS	MXP	MXP	MXP	MXP
18	10'-0	NCP	NCP	MXP	MXP	MXP	MXP
20	10'-0	NCP	NCP	MXP(c)	MXP(c)	MXP(b)	MXP(b)
24	9'-0	NCP	NCP	MXP(a)	MXP(a)	MXP(a)	MXP(a)

Notes:

a) 7'-0 maximum spacing
b) 8'-0 maximum spacing
c) 9'-0 maximum spacing

Vertical Pipes: (All Pipe Sizes)

Pipe Riser Clamp Model	Maximum Vertical Centers
PRV	15'-0
HPRC	40'-0

Insulation shall be asbestos-free calcium silicate; 100 psi avg. compressive strength with a K = 0.38 BTU in/ft_2/DegF/Hr. Insulating structural insert shall be asbestos-free calcium silicate; 600 psi avg. compressive strength treated with water repellant.

Jackets shall be galvanized sheet steel ASTM A-527; straps and load distribution plates to be carbon steel ASTM A-36; fasteners to be ASTM A-307, cadmium plated.

PIPE INSTALLATION:

All piping systems shall be installed so that they can be easily drained by means of drainage of low points of all piping without disconnecting pipe. If not specifically indicated on the drawings, the frequency of draining shall determine whether drain caps, plugs, cocks, or valves are to be used. If other than valves are contemplated, the Architect's permission must be obtained.

All installed pipe lines shall be straight, free from dents, scars, and burrs, with ends reamed smooth, and shall remain straight against strains tending to cause distortion during system operation. The Contractor shall make proper allowance for pipe line expansion and contraction so that no unsightly distortion, noise, damage, or improper operation results therefrom.

Piping shall run only parallel or at right angles to the walls or axes of the building and shall be neatly organized. The Contractor shall study the architectural, structural, mechanical, electrical, and other drawings to eliminate conflict of piping with other structure lighting or other services. Unless specified otherwise, no piping shall be exposed in a finished room, except in shop or storage areas. All changes in direction shall be made with fittings.

No piping shall be run above any electrical panels, electrical equipment or access clearances for electrical for electrical panels or equipment. No piping shall be allowed to run through any electrical rooms.

All piping shall be clean and free from acids and loose dirt when installed and shall be kept clean during the completion of the installation.

Plugs of rags, wools, cottons, waste, or similar materials may not be used in plugging. All piping shall be so arranged to not interfere with removal of other equipment or devices; and to not block access to manholes, access openings, etc. Piping shall be arranged to facilitate equipment maintenance. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. Piping shall be placed and installed so that there will be no interference with the installation of the air-conditioning equipment, ducts, etc. All piping shall be so installed to insure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated and packed, and the glands shall be adjusted at the completion of the work and before final acceptance. All piping shall be erected to insure proper draining. Cooling and heating piping mains may be run level, with traps avoided where possible. Drain valves shall be provided at all low points and manual air vents at all high points in heating and cooling piping. No bushings, short nipples, or street-type fittings shall be used.

Drain valves shall be installed at all low points in all piping systems to allow for complete drainage of piping systems.

When insulated pipes are supported by a roller hanger they shall be protected from damage by suitable pipe covering protection saddles. Saddles shall support pipe on roller and shall be packed with insulation.

Grade:

Soil, waste, and drainage lines shall be graded not less than 1/4 inch fall per foot, unless noted otherwise on the drawings.

Domestic hot and cold water lines shall be graded so that systems can be drained with as few drains as possible. Drains shall be located in convenient and accessible places.

All refrigerant lines shall slope downward in direction of refrigerant flow. Oil traps shall be located at all rises in suction line.

Shutoff valves shall be provided in domestic hot and cold water system and in the steam system at each major junction and at each toilet room branch supply line, hot and cold.

Fire sprinkler piping shall be graded to drain per NFPA-13 requirements.

Welding:

All welding shall be performed by experienced certified welders. Welders must be certified for the materials, procedures, positions, and applicable codes to be used. Performance qualifications and certifications shall be determined in accordance with Section IX, ASME Boiler and Pressure Vessel Code. All welders must be certified within 3 months of beginning welding on this project. When a welder has not used a specific welding process for a period of 6 months, he shall be required to be requalified before beginning procedure. Welders certificates shall be maintained on file at the project site. Any welding performed by noncertified welders will be rejected.

Electric arc welding shall be used between sections of pipe and between pipe and fittings for black steel piping 2-1/2 inches and larger. All changes in direction of pipes shall be made with welded fittings for sizes 2-1/2 inches and larger. All welds shall be of sound metal, thoroughly fused to the base metal and penetrating to the bottom of the joint.

The strength of the finished weld shall be equal to the strength of the pipe. The width of the finished weld shall be at least 2-1/2 times the thickness of the part joined and the thickness of the weld shall be at least 24 percent greater than the thickness of the pipe or fittings.

No direct welded connections shall be made to valves, strainers, apparatus or related equipment. Connections to fanged valves or accessories having fanged connections shall be made with welded companion flanges.

In general, all fittings shall be standard welding type. Weld-O-Lets may be used on low-pressure lines 2 inches and smaller. Under no circumstances shall pipe be notched, mitered, or swaged.

Screwed Connections:

Piping 2" and smaller shall be screwed. All changes in direction shall be made with standard threaded fittings. Under no conditions will piping be notched, mitered or swaged.

All piping shall be accurately sized to measurements established at the building and worked into place without springing or forcing. Proper provisions shall be made for the expansion and contraction of all pipe lines. Screw joints shall be made with a lubricant applied to the male threads only. Threads shall be full cut and not more than three threads on the pipe shall remain exposed.

All pipe connections to roof drains shall be made with a relatively short riser and a horizontal swing joint so that, as the camber leaves the roof structure, the roof drain will not be forced upward.

Joints in Copper Piping:

Pipe shall be cut square and true. The end shall be deburred, reamed, and/or sized as necessary. The pipe shall be cleaned with medium grit emery cloth and, if the fitting socket is tarnished or shows oxidation, it shall be likewise cleaned. The pipe shall be inserted in the fittings and heat shall be applied to the fittings. Joints in copper piping for all above grade domestic water piping shall be 95/5 or Stay-Safe 50 solder. Solder shall be Silfos or Silverflow for all refrigerant piping joints and any below grade piping. No "Super" fluxes or flux core solders or lead solders shall be used. Only silver shall be used.

An approved isolation fitting shall be installed at the junction of all steel and copper pipes. This shall not apply to copper black steel connections at radiation convectors, cabinet heaters, and coils.

Caulked Joints:

Caulked joints in hub and spigot sanitary soil and vent piping shall be packed firmly with white Oakum Sealite No. 110, or approved equal, and caulked with pure molten lead not less than 1 inch deep. The Contractor may use Ty-Seal or approved equal resilient gasket joints in lieu of lead and Oakum for sanitary soil, waste, and vent piping or hubless cast-iron pipe joint with stainless steel and teflon sleeve and clamp above grade and cast iron M.G. Couplings below grade.

Floor, Wall and Ceiling Plates:

Beaton and Caldwell or Grabler nickel-plated floor, wall, and ceiling plates of adjustable type that can be applied after pipes are in place shall be provided. They shall be installed on all exposed uninsulated pipes passing through walls, floors, and ceilings.

Pipe Sleeves:

All pipes passing through wall, floor, or ceiling construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor, ceiling, or wall and shall be cut flush with each surface except in unfinished areas. Unless otherwise specified, sleeves shall be two pipe sizes larger in diameter than the uninsulated passing pipe. Sleeves in outside walls shall be made of galvanized steel pipe with a water-stop flange.

Sleeves in all finished room floors shall be left flush with floor and caulked watertight around pipe; sleeves in unfinished room floors and under cabinets shall be left standing 2 inches above finished floor. All sleeves are to be caulked watertight with sealing mastic.

All sleeves, except in concrete walls, shall be furnished and installed as work of this Section and installed as work of Division 3, Concrete.

Sleeves for concrete or masonry shall be galvanized steel or cast iron pipe. Sleeves for stud walls shall be 26-gauge galvanized iron. These shall be furnished and installed in close cooperation with the craft involved. These sleeves shall be of sufficient size to readily clear the pipe or pipes and insulation passing through sleeve. Everything more than 6 inches in diameter or groups of multiple piping shall be approved by the Architect.

Bare Pipe: All pipe penetrating fire walls and floors shall be encased in adjustable sheet metal cans sized for maximum one-inch spacing between pipe and can. Spacing shall be packed on either end with UL rated ceramic fiber strip insulation. Pipe Shields, Inc., Model WFB.

Insulated Pipe: Same as for bare pipe, but with the addition of a 360 degree water-proofed calcium silicate insert with metal shielding, all sized to extend to a minimum of one-inch beyond wall or floor. Pipe Shields, Inc., Model WFB-CS-CW for chilled water, and Model WFB-CS for all other insulated lines.

Sleeve and packing shall have the same fire rating as the construction in which they are installed. Any substitutions must have passed the ASTM E-119 test per UBC 43-1 for pipe penetrations.

All holes required for piping through floors or walls, where sleeves have not been installed, shall be core drilled one pipe size larger in diameter than passing pipe.

This Division shall be responsible for the proper sizing and positioning of all necessary boxes and sleeves through walls and floors to accommodate this work.

EQUIPMENT CONNECTIONS:

All piping connecting to pumps, converters, chillers, boilers, heat exchangers, fan units and other equipment shall be installed without strain. The Contractor shall be required as directed to disconnect piping to demonstrate that it has been so connected.

Flexible connections shall be provided at the inlet and outlet of each pump, chiller, and isolated equipment and at other locations indicated on the drawings.

EXPANSION AND CONTRACTION:

The Contractor shall make all necessary provisions for expansion and contraction of piping with Victaulic or Central Sprink, Inc. couplings, expansion joints, offsets, or expansion loops as required or shown, to prevent undue strain.

CROSS CONNECTIONS:

No plumbing fixture, device, or piping shall be installed that will provide a cross connection interconnection between a distributing water supply for drinking or domestic purposes and a polluted supply, such as a drainage system or a soil or waste pipe, which will permit or make possible the backflow of sewage polluted water, or waste into the water supply system.

END OF SECTION 23 0300

SECTION 230400 - PLUMBING SYSTEMS

GENERAL CONDITIONS:

All pertinent sections of Section 230100, Division 23, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

SCOPE OF WORK:

This work shall include all new plumbing fixtures, fixture trim specialties, drains, etc., required for the new work required for the plumbing system.

CODES AND STANDARDS:

All work included in the scope of this specification shall conform to the latest adopted versions of applicable codes and standards, including the following:

International Plumbing Code

International Building Code

International Mechanical Code

UOSHA

IAPMO

PDI

Utah State Building Board Planning and Design Criteria To Prevent Architectural Barriers for the Aged and Physically Handicapped.

SUBMITTALS:

Submit product data in accordance with Division 1 and Section 230100. Submit the following:

Plumbing Fixtures and Accessories
Gas Pressure Regulators

TESTS:

Sanitary System: The sanitary soil, waste, vent, and roof drainage piping shall be tested by plugging all outlets and filling the lines with water to the highest roof opening. The water level shall not drop more than 3 inches in 1 hour. All joints within the building shall be inspected for visible leaks.

Water Lines: All water lines shall be tested hydrostatically at 200 psi and shall show a pressure drop not more than 5 psi in a 24-hour period.

Gas Lines: Gas lines shall be tested with air at a pressure of 60 psi and show no drop in pressure. The Gas Company shall test all gas lines for leaks in compliance with Gas Company regulations.
The pressure shall remain on all parts of the system for a minimum of 12 hours to permit complete examination and inspection.

Defective Work: If inspection or tests show defects, such defective work or material shall be replaced or corrected and inspection and tests shall be repeated. All repairs to piping shall be made with new materials. No caulking or screwed joints or holes will be acceptable.

All defects in material and workmanship which appear during the test shall be promptly remedied and the test shall be reapplied.

Enclosed Piping: Any piping which is to be insulated, placed within the construction, or otherwise concealed shall be carefully tested before being permanently enclosed.

Test Instruments: All testing shall be performed in the presence of the Architect and his Mechanical Engineer and shall meet with their approval. Instruments required for making the tests shall be provided by this Contractor. Relief valves set to avoid excessive pressure during testing shall be provided.

Required Adjustments: Before final acceptance of the piping system as a whole, this Contractor shall make all required adjustments, including controls, flush valves, etc., and shall place the entire piping system in a perfect operating condition. At the completion of the work, this Contractor shall furnish the Architect with all certificates of inspection.

GENERAL REQUIREMENTS:

Existing Lines:

Any utility line uncovered during construction that is not clearly defined on the drawings shall be immediately brought to the attention of the Architect and Owner. The Owner and Architect will subsequently inform the Contractor what should be done. A change order shall be initiated in accordance with the General Conditions for such occurrences. Relocation of any existing piping shall be done with the same material and fittings as the original installation. Damaged or removed insulation shall be repaired and/or replaced.

Vents:

The entire system shall be properly vented to atmosphere and all gases shall be discharged at points not less than 14 inches above the roof line. Each fixture shall be back-vented on the discharge side of safe water seal and arranged for free passage of all gases to atmosphere. Vent lines are to be offset, if necessary, so that they will not pierce the roof at points closer than 5 feet 0 inches from the edge of the roof, except where shown otherwise on the drawings.

Charcoal Vent Filters

Provide charcoal vent filters on all vents through the roof (VTR's) for the entire project. Charcoal devises and filters to be as manufactured by Sweet Septic System. Contractor to provide one carton of Sweet Air filters.

Cleanouts:

Full size cleanouts shall be installed at the base of each soil waste or rainwater stack and at the end of each horizontal run of sanitary piping. All other cleanouts shall be installed where shown on the drawings and where required by State, local, or National Plumbing Codes.

Cleanouts shall have cast-iron bodies with threaded brass screw plugs. They shall be the full size of the pipe line in which they are installed, up to and including 4 inches. All cleanouts shall be installed in

locations easily accessible for rodding. Where stacks or other piping is concealed, cleanouts shall be installed above the floor with extensions made to the finished wall surface. Cleanouts in walls shall be J. R. Smith 4402 with countersunk plugs and round stainless steel access covers. In floors, J. R. Smith 4023 square top cleanouts with countersunk plugs and round scoriated polished nickel bronze access covers with frames shall be used.

Cleanouts shall be J. R. Smith, Zurn, Wade, or Josam. J. R. Smith references are used herein.

Traps:

Each fixture and appliance installed in the work and discharging water into the sewer or house drainage system shall have a seal trap arranged in connection with a complete venting system and shall be installed so that all gases shall pass freely to the atmosphere with no pressure or siphon condition on the water seal. Each fixture shall have a water seal of not less than (2) inches and not more than (4) inches except where a deeper seal is found necessary by the Administrative Authority for special conditions.

Flashing and Sleeves:

Furnish and install on each pipe passing through the roof a Stoneman Stormtite four pound seamless lead flashing assembly extending horizontally not less than 12-inches all around. Flashing to have steel reinforced conical boot and counter-flashed with a hooded cast iron counter-flashing. Seal the neck of the flashing to the pipe with permaseal waterproofing compound and secure the counter-flashing to the pipe with vandal proof screws. Fill the top annular space of counter-flashing with epoxy compound. Alternate using open top models of all pipes. See specification Section 230100.

Sleeves for pipes passing through walls, floors or ceilings shall be as specified in Section 230300.

Burying Pipe:

Outside pipe placed underground is to be buried a minimum of 4 feet to prevent freezing. All backfill shall be mechanically compacted to meet the density requirements set forth in Division 2.

Courses of Water Pipes:

Water pipes shall not be exposed in finished rooms except where noted on plans where run in areas with no ceilings or as permitted by the Architect, except the finished brass supplies that are a part of the fixture trimmings. Pipes are to be run in tunnel, furred ceiling and walls, and behind or under cabinets as shown.

Sewer Location:

Where the location of the sewer is not clearly defined by dimension on the drawings, it shall not be closer than 10 feet horizontally to a water main or service line, except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, where they shall cross each other at neat 90-degree angles. Verification of existing sewer main elevations shall be made prior to connection or installation of any new lines. Should installation at the minimum required slope be attainable at the connection points shown, the Architect shall be immediately notified before installation of the line possible.

Piping Layouts:

Layout of piping shown on drawings is in a general sense diagrammatic as to the exact location of piping. It is to be understood by the Contractor that unforeseen conditions and obstacles at the site may not permit the running of piping as scaled from the drawings, but changes shall not be made without the written permission of the Architect. The Plumbing Contractor shall check toilet room details as shown on the Architectural drawings. He shall check the grade of a waste line with a transit before installing the pipe.

See the Plumbing Fixture Schedule on plans for the sizing of connecting lines to each fixture.

Floor Drains:

Exposed surfaces of floor drains, unless otherwise noted, shall be finished in nickel bronze. Floor waterproofing materials shall be securely anchored in the clamping ring of the floor drain. Floor drain strainers in ceramic tile floors shall be square. The tops of all drains shall be set flush with the finished floor level except where floors are warped to drains, where these shall be set flush. The Contractor shall consult with the trades responsible for adjacent work before establishing final finish elevations. Openings shall be core drilled.

Waste and Vent System:

A complete plumbing waste and vent system shall be furnished and installed. It shall be installed in strict compliance with the Plumbing Code. It shall be incorporated into the space constraints in the building.

EQUIPMENT AND INSTALLATION:

Vacuum Breakers:

All water outlets with hose ends where backflow is possible and where required by code shall be complete with vacuum breakers. Where vacuum breaker is not specified with fixture trim, the breaker shall be installed in the supply line to the fixture.

Vacuum breakers shall be of chrome-plated brass, or specified finish, and shall be FEBCO 730C or Watts unless otherwise specified. Vacuum breaker shall be in accordance with American Society of Sanitary Engineers (ASSE) Standard 1011 and shall be capable of being drained if located where freezing is possible.

Pressure Regulating Valve: (Gas):

A gas-pressure regulator shall be installed on the main gas line to the building and other locations shown and for each gas-burning appliance. The regulator shall be a single-seated cast-iron body gas-pressure-reducing valve where shown on the drawings. The valve shall be installed complete with gas cock and union upstream of the valve and a union downstream of the valve. Gas-pressure-reducing valves shall be Fisher or Rockwell and shall be vented to the outside.

Access Panels:

Access panels shall be installed over all concealed valves, cleanouts, and any other concealed equipment that may require access for operation, maintenance, and repair. Access box locations shall be verified with the Architect prior to installation.

Tile Walls: J.R. Smith No. 4730 chrome plated
Ceilings: J.R. Smith No. 4760 bonderized and primed.

STERILIZATION:

After the new system is completed and tested for pressure, and just before the building is ready to be occupied, this Contractor shall sterilize the system as follows: After the mains are flushed, a water and chlorine solution concentrated to 250 ppm shall be introduced. The treated water and chlorine solution shall be retained for not less than 8 hours before final flushing out of the system until the chlorine content is less than 0.2 PPM.

WATER HEATER: (GAS)

A water heater of the size and capacity shown on the drawings and as manufactured by Lochinvar, State, Bradford, Rheem or AO Smith, shall be furnished and installed.

The tank shall be constructed in accordance with the ASME Code and stamped with the appropriate symbol for 150-psi working pressure. The tank lining shall comply with NSF 61.

The water heater shall be insulated with a heavy-density fiberglass insulation and trimmed with a baked enamel, steel jacket. Unit to comply with ASHRAE 90.2.

ASME pressure and temperature relief valve, temperature limiting device anode rod and a drain valve shall be factory installed.

Provide vertical concentric vent kit and PVC vent piping, PVC air intake piping. Install in accordance with manufacturers recommendations.

PLUMBING FIXTURES:

This Contractor shall furnish and install all fixtures shown on the drawings or specified hereinafter, shall make all parts complete, and shall leave the entire system in perfect working order. He shall clean and adjust all fixtures before leaving the job. Any damaged or cracked fixtures shall be replaced at the Contractor's expense.

The fixtures shall be all new and complete as shown or described in catalog or as required for the work. The fixtures shall include accessible loose key compression stops above the floor in supplies to all fixtures and cast brass P-traps unless otherwise shown. Trim for all fixtures shall be chrome plated and all trim shall match in design. All exposed piping in occupied spaces shall be chrome plated. Supply faucets shall have renewable seats and barrels.

Stops shall be provided in all water lines to individual sinks, roughed-in locations, etc., as part of the plumbing contract. All fixtures shall be caulked to the floor or a wall with water-resistant white butyl rubber caulking compound.

Fixtures shall be Kohler, Crane, American-Standard, Eljer, or an approved equal. Specialties shall be Zurn, Josam, J.R. Smith, or Wade.

Supplies and stops shall be Frost, Brasscraft, Kohler, Eastman, U.S. Brass, Robert Mfr. or approved equal. P-traps shall be Frost, Kohler, Sanitary-Dash or approved equal. Grid strainers shall be Chicago or Dearborn.

Lavatories shall be the height specified on the Architectural drawings. Lavatories shall be supported on Smith 700 or 800 carriers.

Floor drains and floor sinks shall be furnished with clamping collars where a waterproof membrane is provided. Membranes will be required for all drains installed above grade. See architectural drawings for additional locations of membranes.

Plumbing Fixtures: See schedule on drawings.

END OF SECTION 23 0400

SECTION 230650 - ICE PLANT

GENERAL CONDITIONS:

General Requirements:

This section covers the complete work for the Ice Plant equipment and installation and is governed by the conditions of Division 23 and Division 26 for any of the electrical work.

This contractor shall be fully experienced in R-717 refrigeration systems, particularly in ice rinks including compressors, brine chillers, ammonia receivers, evaporative condensers, ice rink piping, ice rink floors etc., Approved contractors for the work of 230650 are Ice Builders, Cimco, and Pace Industrial.

Work Included:

The work includes the supply, installation and start-up of a complete operating artificial ice plant to make and maintain one (1") inch to one and one quarter inches (1-1/4") of ice on a concrete floor for one new 85 x 200 foot ice rink and the existing Olympic sized ice rink .

Design conditions are as indicated and the plant shall make ice at about 1/16 inch per hour and maintain the ice as low as 14°F all year including the summer.

Design operating conditions are :-

Outdoor temperature	65° F Wet bulb	93°F Dry bulb
Indoor temperature	50% max. rel. humidity	60°F Dry bulb

Work under this section shall include all labor materials and equipment to complete the work for the entire project and shall include but not be limited to the following:

An enlargement of the existing refrigeration system including compressors, shell and tube brine chillers, heat exchangers, vessels, pumps, piping, evaporative condenser, and accessories.

Supplying and installing all components and equipment, complete with refrigeration controls and motors as shown on plans and specified. Compressors shall be supplied complete with starters as indicated.

Supply and install all refrigeration plant controls and ensure proper working of all controls and electrical devices associated with the refrigeration system. Install wells in piping and/or mount pressure and electronic devices as required. Provide electrical contractor with necessary wiring diagrams and conduit layouts for starters, controls, etc.

Supplying all tools, supplies, scaffolding and temporary lighting etc., for the installation of work.

Supplying and installing all refrigerant and brine piping, headers, fittings, supports and valves.

Supplying and installing all hangers, inserts, header and pipe supports, wall and floor sleeves.

Supplying and installing all floor piping chairs and all under floor piping

Cutting, patching and making good floors and walls for reception of this work as covered under other sections of the specifications

Supply and install all electrical devices, controls, wiring etc. to ensure proper working of all controls and electrical devices required for proper operation and safety of the refrigeration system. Installing wells in piping and/or mounting pressure and electronic devices, and assist and coordinate with the Refrigeration Automatic Contractor (RAS) contractor.

Supplying and installing all water piping from a valved water supply in the compressor room to all water cooling apparatus, circulating piping and other equipment that is shown or specified.

Supplying and installing all insulation and the insulation saddles for all refrigerant and brine pipe lines, valves and vessels.

Supplying supervision during floor construction to ensure that there is no damage to the floor piping and to make all repairs as required.

Charging the entire system with refrigerant grade anhydrous ammonia, a full charge of oil and a complete charge of treated calcium chloride brine for the new rink brine system.

Starting up, operating, and adjusting all controls under load conditions to ensure satisfactory operation of all components and the system as a whole. This is to include assisting with making the first ice sheet and instructing the operator in the proper operation and maintenance of the plant.

Sizing pipe lines where sizes are not shown on the drawings. They will be sized using best standard practice for refrigeration, water and drain or brine piping sizing, with recommended pressure drops and approval of the engineer.

Labeling and identifying all valves and mains.

Painting all steel surfaces with prime and finish coat.

Providing a one year labor and material warranty and all guarantee work as required by the construction contract.

Structural steel supports for equipment and piping, and all concrete bases and foundations. This contractor will provide detailed drawings as specified under submittals and ensure the supports meet seismic requirements.

Quality Assurance:

This contractor shall apply for and pay for all permits required for the installation of this work.

All materials, construction, installation and work shall be carried out in strict accordance with the latest edition of Uniform Mechanical Code ANSI/ASHRAE 15-1989 Safety Code for Mechanical Refrigeration, ANSI/IIAR 74-2 NEC National Electrical Code, Division 26 ANSI B31.5 Code for Refrigeration piping , including all revisions, and Federal, State and local rules, codes, regulations and safety orders which also apply.

Pressure vessels shall comply with the ASME Section Vlll Code for Unfired Pressure Vessels, and shall be inspected and registered for use in the State of Utah.

This contractor shall employ experienced tradesmen fully qualified under the State and Federal Regulations pertaining to licensing and qualifications of tradesmen.

This contractor shall employ a full time job superintendent to supervise the complete installation. This superintendent will co-operate with all other contractors and the engineer in the proper location and dimensions for equipment bases, placing of anchor bolts, equipment, pipe supports, valving, and headers etc.

Mandatory Pre Construction Meeting

A special pre construction meeting will be held for the ice systems prior to the beginning of the new work installation. Items to be discussed include the ice floor construction, the refrigeration plant, etc. The contractors including sub contractors (ie refrigeration contractor, piping contractors, etc.). The supervisor of each trade will be required to attend including any contractors from “out of town”. The contractor should submit possible dates for this special meeting when he submits his construction schedule.

Standards Of Material:

All materials and equipment shall be new, free from defects impairing strength, durability or appearance and of the best quality available for the purposes specified and shown.

Proposals will be based on equipment where called for as manufactured by the companies listed hereunder. The equipment shall be of size and capacity shown on drawings and\or specified hereinafter.

Evaporative Condensers: B.A.C., Cimco, Evapco

Compressors: Screw: Frick, Vilter, Mycom

Brine Chillers: Frick, Cimco, Vilter, Chilcon, Docal

Shell and Tube Exchangers: Frick, Cimco, Vilter, Chilcon, Docal

Pressure Regulators: Refrigerant Specialties, Hubbell

High Pressure Float Valves: Phillips, Armstrong

Electric Float Switches: Refrigerant Specialties, Magnetrol, Hansen

Solenoid Valves: Refrigerant Specialties, Hubbell, Hansen

Pressure Relief Valves: Henry

Globe, Angle, Hand Expansion Valves: Frick, Henry, York, Vilter, Chilcon, Hubbell, Hansen

Pressure Control Switches: Mercoid, Penn

Brine Pumps: Armstrong, Paco, Weiman, Bell, and Gossett.

Brine Valves: Crane, Jamesbury

Rink Thermostats: Honeywell T755S

Electronic Liquid Sensor: Grasso, Hansen

Shop Drawings:

Prior to delivery of any material to the job site or the start of any work the contractor shall submit to the Engineer for review, six (6) copies of detailed data and dimensional drawings, cuts or samples of the following equipment:

1. Compressors
2. Brine Chiller
3. Heat exchangers
4. Pumps, complete with curves
5. Other Pressure Vessels including Oil Pots
6. Valves and Switches
7. Installation and piping schematics with all piping shown
8. Control Panel and Wiring (clearly identify field wiring)
9. Floor pipe sample c/w test certification
10. Pipe chair
11. Evaporative Condensers

Review of shop drawings does not relieve the contractor of any responsibility as to capability or fit of the item.

Start-Up:

The contractor shall operate all new equipment after it has been installed and pressure tested for a continuous 72 hours or until ice has been made on the floor. During which time he will make all the necessary adjustments to equipment and controls to ensure satisfactory operation, and also instruct the Owner's operating engineers on the maintenance and operation of the equipment installed.

Operating and Maintenance Manuals:

Before start-up, his contractor shall make up and deliver to the Engineer, four (4) operating manuals describing in detail operating and maintenance instructions for all the equipment and controls supplied under the Contract. The operating manuals shall include manufacturer's descriptive literature and parts list, also all shop drawings. These manuals will be to the satisfaction of the Engineer before final payment is released. The manuals shall be enclosed in hard cover binders and shall be indexed as to contents. Provide a minimum of 12 monthly service checks while the refrigeration plant is in operation during the first year to check that the operators are operating and maintaining the mechanical systems properly and keeping maintenance schedules up to date. Forward complete written reports to the Engineer after every visit.

Record Drawings:

Keep on the site, an extra set of drawings and specifications recording all changes and deviations daily. Allow for the work required to transfer site changes to the Engineer's original tracings and for providing the owner a set of sepias marked "Record Drawings".

Guarantee:

This contractor shall repair or renew, free of charge to the Owner, any part of the equipment or work

which proves defective within one year of final acceptance of the work by the Owner. This includes labor, materials, ammonia, oil and the cost of brine replacement due to leaks in the piping.

The screw compressors and their motors and starters shall be warranted as above for 24 months from final acceptance by the Owner.

Compressors - Ammonia:

Furnish and install, as shown on the plans, Rotary Screw Compressors, each with a capacity as shown on the drawing.

The compressor shall have an economizer port, complete with necessary valves and fittings, which shall be suitable to connect to a flash type economizer.

The compressors shall have anti-friction ball bearings, cylindrical roller bearings for radial loads and four point angular contact ball bearings for axial loads.

The compressors shall be assembled into standard screw compressor packages, a separate package for each compressor, designed for industrial refrigeration using ammonia as a refrigerant, shall be factory packaged on a rigid structural steel skid with all components piped and tested and furnished with all motors mounted and shall be equipped with the following:

Drive coupling with OSHA-approved type coupling guard.

Hand wheel type stop valves on suction and discharge connections.

Suction strainer and check valve.

Discharge stop and check valve.

Infinitely adjustable, slider valve, capacity control from a minimum of 25% to 100% to follow the loads with a 75% load cam switch and have automatic variable volume ratio control for three volume ratios - 2.2, 3.5 and 5.0.

Lubrication system shall be designed to operate without an oil pump. Provide oversized "sealed for life" thermosyphon oil cooler, manufactured for 300 PSIG working pressure,- oil temperature 3-way control valve, efficient coalescent oil separator/receiver with heater and sight glass, and oil pressure regulator. Provide oil filter for each compressor and one spare oil filter for each compressor. Provide oil heater.

Complete oil charge and 100% change.

All relief valves and safety devices. Relief valves shall be dual relief valves.

Microprocessor control panel in a NEMA-4X enclosure shall be mounted and wired on the compressor unit. The panel shall contain a microprocessor unit, solid state input-output modules, terminal strip for external field wiring, transducer input terminal strips, power supply, oil heater relay, all safety controls, operating controls, elapsed time meter, data entry keypad, built in continuous operating display in Imperial (and S.I.) units and with all required safety and operating controls. The panel shall have an interface suitable for connection to a remote computer which will also be used to monitor and control the operations of the compressor.

Compressor motors shall be hi-efficiency. squirrel cage induction type and of low noise design, with NEMA Design C or D Construction, open drip proof ball bearing, 1.15 S.F. Class F insulation. The motors will be selected to match the full load at the design conditions without using the safety factor of the motor. Motors shall be of one manufacturer for all compressors.

Supply start-up service and complete wiring diagrams and operating manuals with recommended spare parts list.

Supply reduced voltage Starter to match the requirements of the package control power transformer, oil pump motor starter, compressor motor current transformer and the appropriate interlocks and wiring. Supply complete wiring diagrams. Starters shall be mounted on the compressors.

Evaporative Condenser:

Furnish and install, as shown on the plans, one factory assembled evaporative condenser of counter-flow blow-through design, with single side air entry. The condenser shall have the fan assemblies built into the pan, with all moving parts factory mounted and aligned. All steel components shall be made from hot-dip galvanized steel, with all edges given a protective coat of zinc-rich compound. In addition, a final coating of Zinc-Chromatized Aluminum shall be applied to the unit after assembly to provide additional corrosion protection.

PAN-FAN SECTION - The combination pan/fan section shall be constructed of heavy gauge hot-dip galvanized steel. The fans and motors shall be located in the dry entering airstream. Standard pan accessories shall include circular access doors. The forwardly curved centrifugal fans shall be statically and dynamically balanced. Fan housing shall have curved inlet rings, and rectangular discharge cowls shall extend into the pan to increase fan efficiency and prevent water from entering the fans. Fans shall be mounted on a steel fan shaft supported by heavy-duty, self-aligning, relubricatable bearings with cast iron housings.

FAN MOTOR AND DRIVE -drip proof ball bearing fan motors with 1.15 service factor shall be furnished. Motors shall be suitable for outdoor service and for variable speed control by a variable frequency drives . Each motor shall be located in a protective enclosure on an easily adjusted heavy-duty motor base. V-belt fan drive shall be designed for not less than 150% of motor nameplate horsepower. Drive and all moving parts shall be protected by removable hot-dip galvanized screens and panels.

COIL SECTION - The heat transfer section of the condenser shall be encased with hot-dip galvanized steel panels and the section shall be removable from the pan. The condensing coil shall be all prime surface steel, tested at 350 psig air pressure under water and hot-dip galvanized after fabrication. The coil shall be designed for low pressure drop with sloping tubes for free drainage of the liquid refrigerant.
WATER DISTRIBUTION SYSTEM - Water shall be distributed uniformly over the condensing coils to insure complete wetting of the condensing coil at all times. The system shall consist of hot-dip galvanized steel header and spray branches with plastic distribution nozzles having a minimum opening of 19 mm x 8 mm. The branches and spray nozzles shall be held in place with snap-in rubber grommets providing quick removal of individual nozzles or complete branches for cleaning or flushing.

ELIMINATORS - Eliminators shall be constructed of non-corroding PVC and be removable in easily handled sections. They shall have a minimum of three changes in air direction with hooked leaving edge, and shall direct discharge air away from the fans and limit drift loss to less than 0.001% of the total water circulated.
Sump Basin Heater – Immersion heater shall provide freeze protection for the pan water. Heater shall be

capable of maintaining 40 F pan water temperature. A remote thermostat with sensing bulb, shall be located in the pan. A low water level control shall prevent heater operation unless heating elements are fully submerged.

Water Circulation Pump – a close coupled, bronze fitted centrifugal pump equipped with a mechanical seal, shall be mounted on the pan and completely piped to the suction strainer and water distribution system. It shall be installed so that it can drain freely when the pan is drained.

Brine Chiller - Ammonia:

Furnish and install brine chillers sized as called for on the drawing Schedules for chilling 1.22 specific gravity calcium chloride brine. Each chiller shall be equipped with a surge drum which shall be connected by pipe stub ammonia connections.

Each chiller shall be equipped with 16 ga Astm SA214 carbon steel tubes.

Each assembly shall have all controls as shown on the drawings including shut-off valves.

Each chiller shall be complete with stand separated from the chiller with 3 inch hard wood blocks, a surge drum sized to prevent liquid carry-over, oil pot and drain, 3 level eyes and dual relief valves.

The chillers and surge drums shall be designed for 250 psig working pressure on the shell side and 150 psig on the tube side and constructed as outlined in paragraph, Quality Assurance.

Brine Underfloor Heat Exchanger:

Furnish and install a horizontal shell and tube water brine exchanger for under floor heating sized as called for on the drawing Schedules. It shall be complete with wall mounting connections and inlet and outlet connections for pipe sizes as shown on the drawings.

The tube side shall be designed for 300PSIG operating pressure and 350°F operating temperature and the shell side for 100PSIG and shall be constructed as outlined in paragraph, Quality Assurance.

Snow Melt Heat Exchanger:

Furnish and install a horizontal shell and tube water refrigerant exchanger for snow melting water heating sized as called for on the drawing Schedules. It shall be complete with wall mounting connections and inlet and outlet connections for pipe sizes as shown on the drawings.
The tube side shall be designed for 300PSIG operating pressure and 350°F operating temperature and the shell side for 100PSIG and shall be constructed as outlined in paragraph, Quality Assurance.

Brine Pumps:

Furnish and install, as shown on the plans, base mounted flex-coupled all iron fitted, single stage, double ball bearings, frame mounted centrifugal pumps as specified on the drawing Schedules.

The pumps shall be fitted with stainless steel shafts, mechanical seals suitable for the Calcium Chloride (CaCl) brine and the pump shall be mounted on a cast iron base complete with an 1800 nominal RPM motor and shall be realigned by this contractor. Submit pump curves for final approval

Brine Balance Tanks:

Supply and install reinforced polyethylene brine expansion tanks. Brine cooling expansion tank shall be specified on the drawings. Install tanks above the highest point of the brine systems with vent to atmosphere and overflow piped to a drain.

Refrigerant and Oil:

Furnish and charge into the system sufficient refrigeration grade anhydrous ammonia to provide an adequate receiver seal with all equipment in normal operation.

Furnish sufficient compressor lubricating oil for two complete charges plus an additional 30-day period. Provide oil charging pump.

Furnish and charge into system complete charge of calcium chloride inhibited with an organic, environmentally friendly, corrosion inhibitor to a specific gravity of 1.223 suitable for a freezing point below -16°F and pH of 6.9 - 7.5. Provide a pH testing unit and hydrometer.

Ammonia Piping Materials:

All pipe shall be ASTM A-53 or A-106 seamless or electric resistance welded black steel. Pipe 1-1/4" and smaller shall be Schedule 80 (extra heavy). Pipe 2" to 10" shall be Schedule 40 (standard). Pipe 14" and larger shall be standard weight. All pipe shall be new and free of pitting, corrosion and excessive rust. All pipe shall be cleaned to remove excess varnish and protective coatings as may exist when purchased. Interior shall be oiled with a refrigeration grade oil. After oiling, ends to be capped and exterior spray or brush painted with Rustoleum #769 Red primer. Pipe to be delivered to job site in this condition.

Except where otherwise specified on drawings, pipe fittings to be used shall conform to the following:

1-1/4" and smaller shall be forged steel, 3000#, ASTM A-105 grade 2 black steel. Fittings to be socket weld except 1/2" and smaller where threaded may be substituted.

2" and larger shall be butt weld, standard weight, ASTM A-234 grade B black steel. Ells to be long radius (1-1\2 R). Pipe bends may be used in place of ells where space permits provided there is no reduction in cross-sectional area.

Valves shall be specifically designed for ammonia service and be of cast or forged steel material. All valves, both manual and automatic, 1/2" and smaller may be screwed if a flanged union is provided to permit removal of valve without cutting the pipe. Valves 3/4" and larger shall be flanged. Valves shall be certified to have been factory tested at 300PSIG air pressure under water and found tight. Valves generally shall be same size as lines in which they are installed.

Flanges shall be of tongue and groove type specifically designed for ammonia service. Flanges may be of either socket weld or weld neck type. Flanges 1" and smaller may be of oval 2-bolt type. Flanged 1-1/4" through 4" shall be of square 4-bolt type. Flanges 5" and larger shall be round type.

Piping Materials:

Brine piping shall be ASTM A-53 standard weight (Schedule 40) ERW steel pipe for underfloor and cooling floor headers, vent and drain piping. Flanges shall be provided at all valves and equipment for

servicing. Valves shall be butterfly or gate and of all iron construction suitable for calcium brine service.

Ice floor and subfloor heating, brine headers shall be shop fabricated. Supply headers for ice floor headers and under floor headers shall have 3/4" Schedule 80 pipe nipples. Return headers for ice floor headers and under floor headers shall have 3/4" Schedule 40 pipe nipples. Both ends of the nipples shall be reamed and the protruding end shall be ground smooth for the plastic pipe. The nipples will be securely welded into the header pipe with leak-proof welds. The ends of the headers shall be fitted with 1-1/4" nipples welded in for screwed air bleed and drain valves.

The existing snow melt pit piping shall be removed. The new snow melt pit piping shall be shop fabricated to fit the new snow melt pit configuration. Field verify the exact dimensions to accommodate the pit shape and the existing drain. Headers shall have Schedule 40 steel pipe nipples at not more than 4" centers. Both ends of the nipples shall be reamed and the protruding end shall be ground smooth. The nipples will be securely welded into the header pipe with leak-proof welds. The ends of the headers shall be fitted with 1-1/4" nipples welded in for screwed air bleed and drain valves. The entire coil and pipe connector that will be exposed to the water in the pipe shall be epoxy painted.

Plastic floor pipe and subfloor heating pipe shall be manufactured from PE3408/3608 high density, black polyethylene resin as defined in ASTM Standard D 2239 material and be suitable for ice rink application with a working pressure of 100 psig at 73.4°F. It shall be supplied in full lengths of the floor/pit surface and with an inside dimension of not less than 1.049" I. D. and a wall thickness of 0.10 inches. Return bends shall be assembled using HDPE fusion fittings.

Pipe spacers shall be made from a 10 Ga. sheet metal strip and 3/16" dia rods at 2 foot centers across the floor width.

Flatness of Ice Floor:

The ice floor shall be installed with the flatness and levelness as listed on the drawings or better. The contractor shall survey the floor after it is poured using methods to determine either the F-no.s per ASTM E1165, or by using differential leveling methods on 5’-0” grids to determine the flatness and levelness of the floor. The results shall be submitted to the engineer for review.

Snowmelt, Water, Air and Drain Piping Materials:

Water, air and drain lines 2" and smaller shall be standard weight copper Type L pipe. Lines over 2" shall be standard weight Schedule 40 galvanized steel pipe.

Insulation Materials:
Snow melt piping shall be insulated with 1/2" fiberglass insulation with all service jacket.

Insulation for refrigerant piping and ice floor brine piping in the compressor room shall be polyisocyanurate, meeting the requirements of density (average) 2.05 lbs/cu.ft., thermal resistance (K factor) 0.19 B. T. U.- in./hr-sq.ft. - °F. Wall thickness shall be as follows supplied in minimum three foot lengths.

Pipe Sizes	Insulation Thickness	
	R-717 Piping	Brine Piping
1/2 - 1-1/4	1-1/4	
1-1/2 - 5	2	

5 - 14	2-1/2	1-1/2	
Vessels	3		
Controlled Pressure Receiver	1-1/2		

2-1/2" or more thickness shall be in 2 layers with end and longitudinal joints staggered.

Ice floor brine piping in the header trenches and the headers shall be insulated with AP Armaflex in 3/4" thickness.

Foil Laminate shall be a Kraft paper and aluminum foil laminate vapor barrier meeting the following requirements:

Permeance - ASTM TEST E96-66, Procedure A: Dry cup - 0.02 perms

Aluminum foil thickness: Minimum - 0.001 inches (1 mil)

Adhesive shall be Armstrong #520 adhesive.

Reinforcing fabric shall be 20 x 20 mesh glass cloth.

Coating Compound shall be Childer's Chil-Perm metallic grey CP-30-1.

All insulated piping in Refrigeration plant shall have a protective jacketing.

Protective Jacketing, shall be 0.016" to 0.020" flat aluminum jacketing manufactured of Type 3003 (3s), 5005 (5s) or 5100 aluminum. The aluminum jackets shall be supplied in 36"x 48" sections. Elbow covers shall be factory preformed aluminum covers of .020" metal thickness.
Protective jacketing may also be color coded PVC jacket.

Banding shall be 1/2" x 0.020" 304 stainless steel.

Saddles shall be 16 gauge galvanized sheet metal.

Note: No wheat paste, staples or other materials not specified shall be brought on the job site.

AP Armaflex elastometric thermal insulation shall be as manufactured by Armstrong Corporation in tubing and sheets as required.

Adhesive shall be Armstrong 520 Adhesive

EXECUTION:

System Cleaning:

This contractor shall leave the interior of the piping, vessels and all equipment in good, clean condition. Piping shall be cleaned out before and after installation. Thoroughly blow out all dirt, scale and foreign matter with compressed air or dry nitrogen.

Ammonia Piping Installation

This contractor shall furnish and install all refrigerant pipe and fittings, manual and automatic valves, strainers, controls, etc., as shown on the drawings and also items not shown which are required for a

complete operating system, such as gauge, control and vent piping and hangers.

All piping shall be run as shown on the drawings and be run plumb and straight and generally conform to the runs shown on the drawings and slope in the direction of flow by at least one per cent. Piping shall be installed as close to ceiling as possible.

Before each piece of pipe is put in place, it shall be swabbed with a lint free cloth soaked in clean ammonia compressor oil.

All pipe-to-pipe connections shall be butt-welded. Burrs formed by cutting shall be removed by reaming. Pipe ends shall be properly scarfed before welding and streamline type backup rings with pipe spacing lugs shall be used on all butt-welded joints 2" and larger.

All thread joints (1/2" and smaller) shall be made with litharge and glycerine, Expando or other suitable joints compound as approved.

Branch connections of the same size as the main shall be made with factory fabricated fittings. Branch connections smaller than the main may be field fabricated in lieu of factory fabricated fittings.

All piping reducers and caps shall be made with factory fabricated fittings.

Horizontal piping shall have only eccentric reducers with straight sides on bottom.

Manual valve stems shall be mounted in a horizontal position.

Strainers shall be mounted only in horizontal runs of pipe.

Pipe hangers shall be of the trapeze type and all hanger materials shall be hot-dip galvanized after fabrication. Hangers shall be attached to building structure or primary supports. Pipe hangers shall be placed not more than 10 feet apart. Hangers shall be placed not more than 4 feet from each change of direction. Preferably on the side with the longest run.

Chips or burns in undercoat paint on piping to be touched up and all valves and fittings to be primed with Rustoleum #769 Red before insulating or finish painting.

<u>Refrigerant Piping Inspection, Testing and Evacuation:</u>

Welded joints shall be visually inspected. Radiographic examination shall be required for 2% of all welded connections as selected by the engineer. Costs of such inspections and examinations shall be borne by this Contractor.

After installation, piping shall be tested with water free nitrogen at 300 psig on high pressure side and 150 psig on low pressure side. Each threaded, flanged and welded joint and valve packing shall be carefully examined with a soap suds test. Piping must be free from leaks at these pressures. The Engineer is to witness pressure tests. After testing, blow out through drain valves at low points. Open valves wide, quickly, to sweep out any particles of grit or scale.

Defective materials appearing during test shall be replaced. Weld leaks shall be repaired by rewelding. Caulking or any other temporary measures will not be permitted. Procedure shall be repeated until a leak-free test is achieved.

After pressure test, piping shall be evacuated to at least 28" Hg. with a vacuum pump (not refrigeration compressor) and shall hold overnight without rise in pressure. Engineer is to witness vacuum test. Break vacuum with refrigerant grade anhydrous ammonia.

Water, Brine, Air and Drain Piping Installation:

Drain lines shall be wall-supported where possible and shall pitch 2%, except where specified.

Provide plugged fittings in each section as clean outs.

All horizontal piping shall be supported from hangers with a maximum spacing of 8 feet.

Steel brine piping and headers shall be all welded and installed as shown on the drawings.

Plastic pipe for the underfloor and cooling floor shall be installed by double clamping, with stainless steel clamps, to the headers and the return bends. Water shall be the only lubricant allowed to assist insertion of the plastic pipe to the nipples and return bends.

Plastic pipe shall be heated by submersion in hot water to expand diameter of pipe for installation over header nipples. Heating of plastic pipe using torches, flame, etc., is not acceptable.

Underfloor piping shall be installed in a sand bed during backfill operations. The pipe shall be stretched and laid straight at 24 inch centers by staking to the backfill until covered. The piping and headers will be tested as specified before the cooling floor is started.

The cooling floor piping shall be installed straight at 3-1/2 inch centers in spacers to ensure even spacing. After stretching the pipe by tying the return bends to the far end of the ice sheet the piping will be tied to the pipe spacers by plastic strips. The piping and headers will be tested as specified before further work takes place.

Brine Piping Testing:

After installation, brine piping for the floors shall be tested with air to 100 psig and the pressure shall be maintained for 24 hours. During period of construction maintain pressure to a minimum of 50 psig until charging with brine.
Defective materials appearing during tests shall be replaced and re-welding of steel pipe leaks to attain leak free tests and final system.

Insulation Application:

Insulate all refrigerant piping, valves (including compressor suction stop valves and elbows), fittings and other equipment and accessories in contact with low temperature refrigerant and brine in accordance with thickness as specified, including the brine headers in the header trench but not including oil pots, relief, equalizer and gauge lines from a point 6" away from insulated lines or vessels.

When complete, the insulation system shall be completely sealed inside the vapor barrier with no exposed ends. The vapor barrier shall be continuous and sealed off to piping and components before protective jacketing is installed. In no case may the protective jacketing be used as, included in, or considered to be part of the vapor barrier.

For all straight runs of piping requiring single layer insulation, use preformed expanded polyurethane

insulation with the foil laminate vapor barrier attached. Sections need not be staggered. Butt ends shall be pressed slightly together. Gaps will not be permitted.

For multiple layering insulation, the inner layer is to be applied with the end joints of the half sections of insulation staggered and taped tightly together. The outer layer of insulation shall have the foil laminate vapor barrier attached. The butt and longitudinal joints of the outer layer are to be staggered with the inner layer joints.

Saddles shall be provided at points of contact between pipe covering and hangers or pipe supports so as to prevent any overloading and compression of the insulation. Saddles shall cover 120● of the insulation circumference and shall be 14" long for pipe sizes up to 3", and 18" long for larger pipe. Saddles shall be placed outside of the protective jacketing. Band saddles 2" in from each end of the saddle.

For longitudinal joints, the foil laminate shall have at least a 1-1/2" lap. Butt joints shall be sealed with a 3" wide strip of the foil laminate centered over the butt joints and wrapped tightly around the circumference of the insulation so that it overlaps itself by 1-1/2". The lap and 3" wide strip shall be bonded with the adhesive.
The surfaces to which adhesive is applied are to be dry and free of dirt. Apply a coat of adhesive to the foil surface and a coat to the matching area of the Kraft surface. Allow the adhesive to air dry until dry to the touch, but tacky under slight pressure before joining the surfaces. The adhesive is instant-bonding so surfaces must be positioned accurately before contact is made. The time to air dry will vary according to the air temperature and humidity. Under normal conditions, a five to ten minute drying time produces the bond. Drying times in excess of 20 minutes must be avoided. The adhesive must be stored at 70°F and should not be applied when the temperature of the adhesive is 40°F or below.

The adhesive is not acceptable if it is over 18 months old.

When insulation is installed outdoors at 40°F or lower, the following methods are recommended:

Apply the #520 adhesive to the insulation in an area that is above 40°F and then install the insulation in the colder area.

Keep four or five cans of adhesive warm in a room above 72°F Take a warm can of adhesive into the working area. When the adhesive becomes stringy and hard to spread, rotate that can with one of the warmer ones.

Apply the #520 adhesive to the lap surfaces to be bonded and let the adhesive set up. Later when the insulation is in place, the bond can be sealed by applying heat from an electric iron on the lap joint. The iron should be used to evenly heat the foil laminate lap joint, but care must be taken not to scorch the foil laminate surface. The heat reactivates the adhesive to obtain an inseparable bond.

Pipe fittings shall be neatly and tightly covered with two-piece premolded fitting coverings. Any gaps in the joints, or voids under the insulation shall be filled with loose fill insulation or fiberglass. Fitting covers shall be taped securely together. Fittings are to be installed before the straight runs of insulation, except for pipe caps and flanged fittings. Flanged fittings are to be fitted over the adjacent pipe insulation with a minimum lap of 2". Field fabricated elbows are not permitted.

For capped ends of pipe, the straight run insulation shall be extended 2" past the cap. Into the open end of the straight run insulation, a 2" deep plug, cut to fit tightly, shall be inserted.

Valves shall be insulated with factory prefabricated fitting covers, oversized to fit snugly over the valve and of equal wall thickness to adjacent pipe insulation. Valve covers shall be taped securely together. All joints to overlap adjacent pipe insulation by a minimum of 2". Any gaps in the joints, or voids under the insulation shall be fitted with loose fill insulation or fiberglass. Valves installed in vertical piping shall be insulated so that the covering will not trap water.

For the vapor barrier, a uniform coat of the coating compound shall be applied to the insulation; into the wet coating one layer of the reinforcing fabric shall be applied. A second coat of the compound shall be applied over the reinforcing fabric. A final coat shall be applied a minimum of six (6) hours later. The final coat shall present a neat and uniform appearance. Total coverage rate of the vapor barrier coating compound shall be not less than 6 Gal.s / 100 Sq. Ft.. The reinforcing fabric and coating compound shall overlap the adjacent straight runs of insulation by a minimum of 3". The coating compound shall not be thinned or applied below 40°F nor above 100°F.
Vessels shall be insulated with two layers of suitable sized beveled lags or of prefabricated curved segments to fit the particular vessel. All joints shall be staggered and all edges of lags or curved segments fitted tightly together. Apply the segments dry and secure them in place with banding spaced one foot on centers. Side insulation shall be extended the thickness of the insulation past the tank head so that a circular disc cover can be inserted. Fill the voids with loose fill insulation or fiberglass. Insert the circular disc and secure it by skewering to the adjacent side insulation and by tightening the banding around the ends of the adjacent side insulation.

Insulate the entire vessel including the oil leg, vessel supports, incoming headers and controls supported by the vessel with the same wall thickness as specified. The vessel supports shall be insulated to a point 3' - 0" below the insulation on the bottom of the vessel. The vapor barrier shall be the same as specified.
All piping insulation shall have protective jacketing. The jacketing is to be installed with the closing lap facing downward. Butt ends of jacketing are to be lapped 2" in the direction of the downward slope of the piping so as to make each section self draining. For pipe fittings and valves, the final coat of the coating compound will be the protective covering. The banding shall be installed with one band in the middle of the protective jacketing and one band 1-1/2" in from the edge of the protective jacket that is overlapped.

Vessels shall have protective jacketing on their circumferences.

Upon completion of the piping insulation, at the Engineer's request, the insulation sub-contractor will remove random sections of protective jacketing for inspection of the vapor barrier.

Workmanship contractors are reminded that the service life of the insulation depends primarily on the in-place permeance of the vapor barrier. Therefore, the contractor will exercise diligence to provide a vapor barrier free of discontinuities and penetrations.

Metal fasteners or staples are not permitted under any circumstances and if used will be cause for rejection of the vapor barrier and require replacement. Where breaks occur in the vapor barrier jacket during installation, they shall be covered in the same manner as butt joints.

Ice sheet brine piping in the trenches shall be insulated with AP Armaflex which will completely cover the piping and large header pipe with the floor piping nipples protruding, all according to the manufacturers instructions. All joints shall be completely sealed with adhesive and the ends at the nipples sealed to the pipe to prevent any moisture from getting under the insulation.

Pressure sensitive adhesive tapes under any brand name, for sealing butt joints as the finished vapor barrier are not permitted under any circumstances.

Electrical Wiring:

All electrical work shall be subject to the General Conditions and Special Condition included with these specifications.

The work shall include the furnishing of all apparatus, equipment, tools, labor and materials required to complete the electrical installation for the refrigeration system, as indicated on the drawings or specified herein. Included, but not limited to, are the following:

Complete branch circuit power connections from panels MCC, etc. including controls.

All equipment connections within the refrigeration compressor room, including remote condensers and controls, to equipment furnished under refrigeration contract.

All interlock control wiring between motor control center, control panel and/or gauge board.

Installation of motor center, control panel, and gauge board.

Work Not Included:

Main feeder and connections to the incoming sections of electrical panels will be furnished under the building work electrical contractor.

Rules and Regulations:

All work and materials shall be in full accordance with the latest rules of the National Electrical Code together with all applicable State and local ordinances or rules regarding the installation. It shall be the responsibility of the successful bidder to bid in accordance with these rules, and thereafter to comply with the above mentioned rules, even though the work is not shown on the drawings or mentioned in these specifications. Certificates of approval shall be issued by those departments having jurisdiction before the work will be approved for final payment.

Tests:

Upon completion of the work and adjustment of all equipment, all systems shall be tested under the direction of the Engineer to demonstrate that all equipment furnished and installed and/or connected under the provisions of these specifications and/or drawings shall function electrically in the manner required.

All systems shall test free from short circuits and grounds, shall be free from mechanical and electrical defects and shall show an insulation resistance between phase conductors and ground not less than the requirements of the N.E.C. All circuits shall be tested for proper neutral connections.

The electrical contractor shall check the service voltage under maximum and no load, and shall advise owner if not acceptable.

Wiring Materials & Workmanship:

This contractor must conform to the electrical specification for the entire building.

Painting:

Refrigeration contractor shall be responsible for painting of all uninsulated piping, equipment and supports installed under this contract. Painting to be as follows:

Copper tubing, galvanized steel or aluminum pipe and conduit, non-ferrous valves, evaporative condensers and galvanized or cadmium plated hangers need not be painted.

Surfaces to be painted shall be dry and clean. Remove rust scale, loose rust or paint and blisters by scraping or wirebrushing. Remove grease and oil. Bare spots of shop coated steel to be wire brushed and spot primed. Temperature and weather conditions and drying times should conform to paint manufacturer's recommendations.

Compressors, pumps and other machinery, together with steel bases, motors, belt guards, etc., shall be given one coat of Rustoleum #769 Red primer and one coat of Rustoleum New Color Horizons high gloss enamel, of colors designated by owner.

Uninsulated ferrous piping shall be installed with prime coat. After installation is complete, prime coat shall be checked and touched up as required before painting with one coat of Rustoleum New Color Horizons high gloss enamel of colors designated by owner.

Brine headers & piping in the header trench shall be installed with prime coat. After installation is complete, another complete prime coat shall be applied before painting with two coats of heavy duty asphalt base paint.

Pipe and Valve Identification:

Refrigeration contractor shall be responsible for tagging of all valves and the identification of all piping installed under this contract.

Tags shall be of black and white laminated phenollic plastic with 3/16" high engraved lettering and shall be perforated with a galvanized chain.

Valve handwheels shall be color-coded by painting with gloss enamel in accordance with the Valve Identification Schedule.

Valves shall be tagged in accordance with the identification schedule. Tags shall be attached to the valve stem. Where valves are grouped in valve assemblies, only the upstream valve need be tagged, so long as the function of other valves in the assembly is obvious from the piping configuration.

The contractor shall be responsible for the identification of all piping installed under this contract, in accordance with the following:

Standard pipe markers manufactured by W. H. Brady Company or equal shall be applied to pipe or pipe covering as required by OSHA. Color stripe and background color of legend and arrow shall be red with white lettering and arrow for fire protection fluids, green with black lettering and arrow for safe fluids and yellow with black lettering and arrow for dangerous fluids and ammonia.

Pipe markers shall be applied close to valves, adjacent to changes in direction of branches, where pipes pass through walls or floors and at 40' intervals on straight pipe runs. Designation on legend shall correspond with pipe symbol designation shown in the pipe legend on drawing.

In lieu of standard markers, color stripe, background color, legend and arrow may be stencilled on lines with paint of approved colors as specified above and with 1/2" letters for pipes under 1" diameter, 1" letters for pipes 1" to 3" diameter and 2" letters for pipes over 3" diameter. Length of background color will vary as required to fit the designated legend.

When pipe lines are located above the normal line of vision, the pipe marker should be placed below the center line so as to be readily visible to plant personnel.

Contractor should submit specific listing of proposed legend for approval by the Refrigeration Engineer.

Valve Identification Schedule

Line	Line Identification	Valve Handwheel	Valve Tag
Suction	See drawings	Yellow	Suction
Liquid	See drawings	Yellow	Liquid
Discharge	See drawings	Yellow	None Required
Condensate Return	See drawings	Yellow	None Required
Oil Drain	See drawings	Yellow	None Required
Relief	See drawings	------	----
Compressed Air	See drawings	Green	None Required
Cold Water	See drawings	Green	None Required

END OF SECTION 23 0650

SECTION 23 0700 HEAT TRANSFER SYSTEMS

GENERAL CONDITIONS:

All pertinent sections of Section 230100, Division 23, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

SCOPE OF WORK:

Work under this section shall include all labor, materials, and equipment to complete the work for the entire project and shall include but not be limited to the following:

An extension of the hot water heating system for the building, including pumps, piping, and accessories.

Structural supports for all mechanical equipment.

Substantially complete and accurate adjustment of all equipment of this Section. Equipment shall be ready for final adjustment as work of Section 230150.

RELATED WORK:

Pipe insulation shall be as specified in Section 230200.

Concrete bases for mechanical equipment shall be provided by the General Contractor.

Pipe is specified in Section 230300.

SUBMITTALS:

Submit product data in accordance with Division 1 and Section 230100. Submit the following:

Air Vents, Balancing Fittings, and Relief Valves, Fan Coil Units,
Flexible Connectors, Pumps, Packaged Gas Fired, Ox Cooled Rooftop Units.

TESTS:

New heating supply and return piping shall be tested with a 200 pound hydrostatic test. Valves shall be installed as necessary to isolate system. The pressure shall remain on all parts of the system for sufficient time to permit a complete examination and inspection.

Defective Work: If inspection or tests show defects, such defective work or material shall be replaced or corrected and inspection and tests shall be repeated. All repairs to piping shall be made with new materials. No caulking or screwed joints or holes will be acceptable.

All defects in material and workmanship which appear during the test shall be promptly remedied and the test shall be reapplied.

Enclosed Piping: Any piping which is to be insulated, placed within the construction, or otherwise concealed shall be carefully tested before being permanently enclosed.

Test Instruments: All testing shall be performed in the presence of the Architect and his Mechanical Engineer or as otherwise directed and shall meet with their approval. Instruments required for making the tests shall be provided by this Contractor. Relief valves set to avoid excessive pressure during testing shall be provided.

Required Adjustments: Before final acceptance of the piping system as a whole, this Contractor shall make all required adjustments, including controls, flush valves, etc., and shall place the entire piping system in a perfect operating condition. At the completion of the work, this Contractor shall furnish the Architect with all certificates of inspection.

GENERAL REQUIREMENTS:

Air Vents:

Air vents shall be installed on all high points in the heating supply and return piping systems. Each air vent shall consist of a 1-inch pipe chamber 6 inches long. Manual air vents shall be used at all locations.

Manual air vents shall be Jenkins (Fig. 743-G or Fig. 744-G), needle valves, 1/8-inch size, Walworth, Powell, or equal.

Relief Valves:

Bell & Gossett, Watts, Hoffman, or equal pressure-relief valves shall be furnished and installed where called for on the drawings or where required. Pressure-relief valves shall be of the sizes and capacities shown or required to match the total capacity of the unit or system served. The outlet from each relief valve shall be piped to the nearest floor drain.

Expansion Loops, Joints, and Guides:

Expansion loops and joints shall be installed where shown on drawings or where required to relief stress in the piping system. Loops shall be as sized on the drawings. Joints shall be slip type, internally and externally guided, and of steel construction equal to the pressure rating of service lines. Guides shall be single or double, as required, with base and support to the building structure. Two concentric-ring aligning guides shall be provided at each side of loops or joints with spacing as recommended by manufacturer. Joints shall have a minimum 5-year guarantee. Joints shall be Yarway Type W, Flexonics, Adsco, Twin City Hose or equal. Guides shall be Adsco, Flexonics, U.S. Flex, Yarway, Twin City Hose or equal.

Test Tees and Pressure Taps:

This Contractor shall install all necessary test tees and pressure taps to properly balance the system. He shall provide pressure and temperature test tees equal to "Pete's Plugs" where directed by the Balancing Contractor, at each heat pump supply and return connection and elsewhere as needed.

Balancing and Adjustment:

This Contractor shall initially balance and adjust the geothermal systems. Final balancing shall be the work of Section 230150. The Mechanical Contractor shall furnish a mechanic to the Balancing Contractor to assist in the balancing work.

Cleaning of Piping Systems:

The water treatment contractor shall be responsible for cleaning of piping systems. The mechanical contractor is responsible for the costs.

After the systems have been filled and tested and all leaks stopped, they shall be refilled to operating pressure; all air shall be vented and pumps shall be operated for 8 hours with drain valves at pumps open as wide as possible and still maintain the water line in the expansion tank.

The drain system shall next be drained completely and refilled with a solution of 1 pound of trisodium phosphate to each 50 gallons of water. Air shall be vented from the system and the solution circulated with the pump running, for 48 hours. The system shall then be drained completely and flushed with fresh water. All air shall be vented from the system. Adjustment of the water flow to each heat pump unit and any other adjustments necessary to put the system in first class working condition shall be made.

All necessary crossovers and isolation valves shall be provided to isolate necessary equipment, bypass equipment, and to isolate existing utility lines during the cleaning process.

The owner and the engineer shall be notified 48 hrs prior to the commencement of any work and 48 hrs prior to the completion of the work.

Connections to Equipment Furnished by Owner or Other Contractors:

This Contractor shall make connections to all equipment on the job, including that equipment furnished by others, including necessary stop valves, and insulation.

EQUIPMENT:

Installation Check: See Section 230100, par. "Installation Check"

In-Line Circulators:

Circulators shall be Grundfos, Weiman, Bell & Gossett or Armstrong in-line, bronze fitted with ceramic seal, spring coupling, and 1750-rpm, drip-proof motor with overload protection. Circulators shall be substantially supported in piping with a full size leg to floor.

Pump Suction Diffusers:

Pump suction diffusers to match the system pipe size and pump inlet size shall be furnished and installed where shown on the drawings. Units shall consist of angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder. Suction diffuser shall be furnished by pump manufacturer.

Base-Mounted Pumps:

Packless flexible coupled or split case pumps with heavy cast-iron base plate shall be furnished and installed as shown. Pumps shall be securely bolted to vibration inertia base as specified. The weight of the piping shall not be supported on the pumps. Pumps shall be 1750 rpm with bronze impeller, wearing rings, stainless steel shaft, and ceramic seal. Pumps shall be suitable for hot water and shall be suitable

for 250 degrees F operating temperature and 125 psi working pressure.

Impeller shall be shaved to provide exact operating point specified on drawings. Motor size shall be as shown on the drawing, but, if an alternate pump is supplied that could operate in the overload range, a larger motor shall be furnished. Motor shall not operate overloaded.

Pumps shall be Bell & Gossett, Taco, Weiman or Armstrong.

Water Treatment:

The current water treatment contractor serving the existing building shall provide the new water treatment requirements. The mechanical contractor is responsible for all costs. The water treatment contractor shall supply field supervision for the pre-startup flushing and cleaning of all equipment and field supervision for the installation of feeders and equipment.

Incorporate the New Water Treatment Needs into the Existing Water Treatment System.

The water treatment contractor shall be responsible to modify the existing water treatment system to accommodate the new evaporative condenser in its new location and the new heating water systems. The water treatment contractor shall also review the brine and inhibitors being provided by the ice rink contractor for the new ice rink and coordinate with the ice rink contractor for the properly protected brine charge. The water treatment contractor will then incorporate the new rink's water treatment needs with the existing water treatment system.

PACKAGED ROOFTOP AIR CONDITIONING UNIT (RTU'S):

Furnish and install a packaged rooftop, dx air conditioning unit of the size and capacity shown on drawings. Internally wired and fully charged with R-410a and designed to operate at outdoor ambient temperatures as high as 120°F. Cooling and heating capacities are rated in accordance with ARI standards. Unit design to be certified by the American Gas Association (AGA), specifically for Laboratory listed and designed for outdoor rooftop installation. Unit shall be ASHRAE 90.1 compliant.

Each Rooftop Unit shall be piped, wired, tested and shipped in one piece with the option of splitting the unit at the condensing section, and/or between the supply fan section and heat section. Outside air system, return air system, filters, switches, supply air fan and all standard operating safety controls shall be furnished and factory installed. Unit shall have blow-through cooling coil arrangement for high efficiency and sound attenuation.

Unit cooling capacities shall be in accordance with and tested to ARI standard 210/240-89 or 360-85.

Units up to 20 tons shall carry the ARI compliance sticker. Unit minimum cooling efficiency, including the standard supply air blower motor shall be as shown on the plans. Unit shall have a minimum heating system efficiency of 80%.Units shall be safety certified in accordance with UL Standard UL465, and ANSI Standard Z21.47.Unit shall be completely factory assembled, piped, wired and shipped in one piece.

Unit shall be specifically designed for outdoor rooftop application with a fully weatherproof cabinet.

Unit design shall be dedicated bottom supply / return air style system for mounting on a roof curb.

Cabinet shall be constructed entirely of galvanized metal with the exterior constructed of 18 gauge or heavier material.

Access to compressor(s), controls, filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with a quarter turn latch (door fastening screws are not acceptable.)

Air side service access doors shall be fully gasketed with rain break overhangs. Air side access doors will have an internal metal liner to protect the door insulation.

Unit exterior shall be painted with two-part polyurethane paint over a wash primer and a paint grip type galvanized steel.

Wiring shall be color coded and marked with a three digit identification on each end.

The interior air side of the cabinet shall be entirely insulated on all exterior panels with 1" thick, one pound density, neoprene coated, fiberglass insulation.

All openings through the base pan of the unit shall have upturned flanges of at least ½" in height around the opening through the base pan.

Unit shall have decals and tags to indicate unit lifting-rigging, service areas and caution areas.

Wiring diagrams shall be in color and marked to match the color and marking of the wires and shall be both “point-to-point” and “ladder” diagrams.

Diagrams shall also be laminated in plastic and permanently fixed to control compartment door. Installation and maintenance manual shall be supplied with each unit, located in a metal pocket in the control access compartment.

Belt driven supply fans shall have multiple belts as required by the IBC 909 if units are part of the smoke control system.

Blower(s) shall be double inlet with forward curved blades type.

Adjustable V-belt drive shall be provided with a minimum rating of 140% of the motor nameplate brake horsepower when the adjustable pulley is at the minimum RPM.

Blowers, drives and motors shall be dynamically balanced.

Unit shall have a modulating enthalpy controlled economizer with multi-stage integrated economizer and compressor operation for maximum benefit. The economizer shall consist of a motor operated outdoor air damper and return air damper constructed of extruded aluminum, hollow core, air foil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 25 CFM of leakage per square foot of damper area when subjected to 2" WG air pressure differential across the damper. Damper motor shall be spring return to insure closing of outdoor air damper during periods of unit shut down or power failure. A pressure relief damper sized for 100% relief air shall be provided as part of the economizer.

Provide with the unit a CO2 sensor to control the outside air.

The condensing section shall be equipped with direct drive, vertical discharge condenser fan(s). The condenser coil shall be sloped at least 30 degrees from horizontal to protect the coil from damage. Evaporator coil(s) shall be copper tube with aluminum fins mechanically bonded to the tubes.

Evaporator coils to have galvanized steel end casings. Evaporator coils to have equalizing type vertical tube distributors with a top suction connection. Evaporator coils for multi-compressor units shall be circuited with one circuit and expansion valve per compressor. Condenser coil(s) shall be copper tube with aluminum fins mechanically bonded to the tubes. Condenser coil(s) to be sized for a minimum of 10 degrees sub-cooling.

Compressor(s) shall be of the hermetic scroll type with internal thermal overload protection and mounted on the compressor manufacturer recommended rubber vibration isolators.

All units over 7 tons shall be multiple stage and shall have a minimum of 2 stages of capacity control.

Compressor(s) shall be mounted in an isolated compartment to permit operation of the unit without affecting air flow when the compressor compartment is open.

Compressor(s) shall be isolated from the base pan and supply air to avoid any transmission of noise from the compressor into the building area.

System shall be equipped with thermostatic expansion valve(s) type refrigerant flow control. System shall be equipped with automatic re-set low pressure and manual reset high pressure refrigerant controls.

Unit shall be equipped with Schrader type service fittings on both the high side and low pressure sides of the system. Unit shall be equipped with refrigerant liquid line driers. Unit shall be fully factory charged with refrigerant . The lead circuit(s) for RTU-1 shall be provided with hot gas bypass. Unit shall be equipped with a 5 minute anti-short cycle delay timer for each compressor. Unit shall be equipped with 20 second between stage delay timers for each compressor.

Unit shall heat using natural gas fuel and with multi stage heat capacity.

Unit shall be provided with a gas heating furnace consisting of an aluminized steel heat exchanger with multiple concavities, an induced draft blower an electric pressure switch to lockout the gas valve until the combustion chamber is purged an combustion air flow is established. Heat exchanger tubes with separate internal turbulators are not acceptable.

Unit shall be provided with a gas ignition system consisting of an electronic ignitor to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.

Unit shall have gas supply piping entrances in the unit base for through the curb gas piping and in the outside cabinet wall for across the roof gas piping.

Units tubular gas heat exchanger will carry a 10 year warranty.

Unit shall have single point power connection.

Unit shall be provided with terminal strip connections for field supplied supply air smoke detector wired to shut off the unit control circuit.

Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with NEC requirements and shall conform with all applicable UL standards. All electrical components shall be labeled according to the electrical diagram and be UL recognized where applicable. Each unit shall have a 115 volt control circuit transformer, high temperature sensor, system switch, and control circuit fuse.

The supply air fan, compressor and condenser fan motor branch circuits shall be individually fused. Contactors and inherent thermal overload protection shall be furnished for each compressor and condenser fan motor. The supply air fan motors shall have contactors and external overload protection. Main control panel shall be of weatherproof construction with a dead front cover over main power circuit control and strip heaters to keep systems operational down to -20 deg F. A terminal board shall be provided in the bottom of the main control panels for field wiring entrance. A separate key locked control panel shall house all controls for the condensing section.

Unit shall be provided with a factory installed and wired internal disconnect switch with fusing.

Each unit shall be furnished with a factory installed starter.

Unit shall be provided with phase and brown-out protection to shut down all motors in the unit if the phases are more than 10% out of balance on voltage, or the voltage is more than 10% under design voltage.

Roof curbs shall be constructed of galvanized steel. Curbs are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Unit shall be mounted on a factory furnished, knocked down and field assembled roof curb. Roof curbs height shall be 14”.

Filters shall be 2" thick throw away.

Contractor/Supplier shall coordinate electrical requirements, <u>including voltage</u>, prior to ordering the units.

Rooftop units shall be AAON, Carrier or Trane.

END OF SECTION 23 0700

SECTION 23 0800 - AIR DISTRIBUTION, HEATING AND AIR CONDITIONING

GENERAL CONDITIONS:

All pertinent sections of Section 230100, Division 23, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.
See plans for schedules.

SCOPE OF WORK:

The scope of work shall include all labor, material, and equipment necessary to complete the air distribution, heating and air conditioning work for the entire project, including but not limited to the following:

All new ductwork, plenums, sheet metal partitions, and specialties required for the air distribution and ventilating system.

Registers, grilles, and diffusers.

Installation of automatic dampers furnished by the Temperature Control Contractor.

Acoustical lining in ductwork.

Air distribution equipment including exhaust air systems.

Heating and/or air conditioning units and systems.

Installation of all floor and wall blockouts for floor or wall outlets and coordination with General Contractor during concrete pour.

Substantially complete and accurate adjustment of all equipment of this section, ready for final adjustment as work of Section 230150.

Sheet Metal Contractor to furnish a man to assist the Balancing Contractor in the balancing to operate equipment and to change belts and sheaves.

SUBMITTALS:

Submit product data in accordance with Division 1 and Section 230100. Submit the following:

Registers, Grilles and Diffusers
Exhaust Fans
Dampers and Damper Regulators
Duct liner
Prefabricated Stacks and flues
Flexible duct

MATERIALS:

Unless otherwise specified, galvanized iron shall be used throughout, fabricated and installed so that no vibration or noise results. It shall be made from the best grade of galvanized mild steel sheets of the U.S. Standard gauge and shall be free from blisters, slivers, and pits.

All seams shall be hammered and made airtight. The construction of all ductwork, including gauges of metal, bracing layout, etc., shall be in accordance with the following manuals of the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

Ductwork and plenums shall be in accordance with SMACNA, "HVAC Duct Construction Standards, Metal and Flexible", latest edition.

Sleeves for fire dampers in the fire wall shall be 14-gauge steel.

SHEET-METAL GENERAL REQUIREMENTS:

All duct systems shall be constructed to the pressure requirement indicated for the fan serving that duct system. Ductwork systems with a fan pressure requirement less than 2 inches w.g. shall be constructed to meet the requirements of the 2 inch w.g. pressure class. Ductwork on the suction side of the fan shall be constructed to the negative pressure class requirements. Ductwork on the discharge side of the fan shall be constructed to the positive pressure class requirements.

The contractor shall exercise utmost care to obtain a smooth surface inside of all ductwork, absolutely free from small fins, imperfect joints, or other obstructions that cause noise and increased friction. Any additional duct offsets or turns not shown on plans or increases in length of run necessary to overcome obstacles shall be called to the attention of the Architect so that an acceptable rearrangement can be worked out. Under no circumstances shall the cross section of any duct be decreased by dents, pipes, or hanger rods running through it unless otherwise indicated on the drawings. Neither shall the shape be changed without approval. No quick transitions that restrict the area shall be used. Where necessary to gain clearance, the duct seams may be turned inside. Structural and Architectural drawings shall be consulted for areas with restrictive clearances. This work shall be installed in cooperation with other trades so that there will be no delay in progress of construction work.

During the installation, the open ends of all ducts shall be protected by covering them with plastic sheet tied in place to prevent debris and dirt from entering. It is extremely important that the duct system be clean before finish painting is done.

Duct Joints:

All supply air and exhaust air duct joints, seams and fittings must be sealed airtight as required by the SMACNA Manual table 1-2, seal classification A. All return air ductwork joints shall be sealed as required by SMACNA Manual table 1-2, seal classification C. The term "seal" or "sealed" means use of mastic or mastic plus tape or gasketing as appropriate.

All traverse joints on metal rectangular ducts 30" and over and all exhaust ductwork 12" and larger shall be constructed using the Ductmate 4-bolt duct connection system.

The system must be installed according to the manufacturer's instruction and assembly booklet.

The Ductmate or Ward system shall be comprised of a hollow, slip-on flange, containing a factory applied integral sealant and separate corner pieces to connect the two flanges to form a rectangular frame. This

frame shall be affixed to the duct, and bolted together at the corners. Install a gasket between the flanges, and a support cleat to join the flanges on the outside.

The system components shall consist of:

1. flange - 20 ga. roll formed galvanized steel, containing an integral sealant.....
2. corner piece - stamped cold formed galvanized steel, embossed and stiffened.....
3. gasket - closed cell neoprene, 5% max. shrinkage, 5% max. water absorption, self-extinguishing, zero burn rate.....
4. cleat - steel or PVC construction, can be either snapped on, or driven over the joined flanges.....
5. nut and bolt - regular 3/8" x 1" stove bolt, one n/b connects two corner pieces, four n/b per joint.....

Hangers and Supports:

Hangers for ducts up to 18 inches in width shall be placed on not more than 8-foot centers. Ducts 19 inches and over in width shall be supported on not more than 4-foot centers. Hangers shall be placed plumb and shall present a neat appearance. Duct hangers shall be constructed of galvanized band iron 1 x 1/8 inch for ducts up to 36 inches in width. On ducts 37 inches and more in width, hangers shall be constructed from galvanized angles not less than 1 x 1 inch. The use of perforated band iron for duct support is prohibited. Hangers shall extend down the sides of the ducts not less than 9 inches. On ducts less than 9 inches in depth, hangers shall extend the full depth of the ducts. Attach hangers to the ducts with not less than three rivets or Parker screws of the appropriate sizes. It is essential that all ducts be rigidly supported. Where vertical ducts pass through floors or roofs, a flanged sheet metal collar around the duct shall be welded to the duct, and supporting angles shall be rigidly welded to the duct collars and to the structure. Additional supports shall be provided as required. Angles used shall be galvanized and of sufficient size to support the ductwork rigidly. Horizontal round and oval ductwork shall be supported 6 feet 0 inches o.c. with 2-inch wide bands of 18-gauge galvanized steel wrapped around the duct. Oval ductwork in Arena shall be supported by angle iron trapeze hangers located 5'-0" o.c.

Cross-Breaking:

Sheet metal ducts shall be cross-broken on the four sides of each 4-foot panel. All vertical and horizontal sheet metal barriers, duct offsets, elbows, as well as 4-foot panels of straight sections of ducts or plenum walls, shall be cross-broken. Cross-breaking shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure that the surfaces will be rigid.

All exposed ductwork, other than in mechanical equipment rooms shall have flat seams and joints; standing seams shall not be permitted.

Exposed ductwork shall be run in straight runs; transitions shall occur on one side only with the bottom and exposed edge maintaining an even plane. Ducts shall be wide enough to allow the boot down to the diffuser or grille to be as large as the flange so that the flange will not project out beyond the duct or boot.

Low Pressure Ductwork:

Low pressure ductwork shall mean: All ductwork serving fan systems with a fan static pressure requirement of 2.25 inches w.g. or less, all ductwork downstream of VAV terminal boxes, return air and transfer air ductwork. Ductwork shall be constructed to the SMACNA 2-inch pressure class requirements. 2

Round and Oval Ductwork - Medium and Low Pressure:

The round and oval medium pressure and low pressure ductwork and accessories shall be factory fabricated, spiral conduit as manufactured by Ventline, United Sheet Metal Company, Metco, Sheet Metal Products Co., Everdur, or Dees Spiral Pipe and Fittings. The conduit shall be constructed of rust-resistant zinc-coated steel of the sizes called for on the drawings. Conduit 3 inches to 8 inches in diameter shall be 26-gauge steel, 9 inches to 22 inches in diameter shall be 24-gauge steel, 23 inches through 36 inches in diameter shall be 22-gauge steel, 38 inches through 50 inches shall be 20-gauge steel, 52 inches through 60 inches shall be 18-gauge steel. All conduits up through 60 inches shall be spiral 18 guage lockseam construction. Conduits over 60 inches shall be 14-gauge steel with ductmate connection on 5'-0" o.c. Round ducts 60 inches and below can be triple rib spiral seam with ductmate joints at 10'-0" o.c.

All fittings in the round pipe shall be factory fabricated to match the spiral conduit and shall be of the same manufacturer. All elbows and fittings shall be fabricated from galvanized sheets at least one gauge heaver than connecting conduits. Ninety-degree elbows shall be equal to United Sheet Metal Company type E-5, five-piece construction with a centerline radius of 1-1/2 times the pipe diameter. All elbows and fittings shall be constructed in accordance with SMACNA recommendations.

Shop or job fabricating pipe and fittings will not be acceptable.

Pipe-to-pipe joints in diameters to 60 inches are by slip-fit or by projecting collar of the fitting into the pipe.

Insertion length of sleeve coupling and fitting collar is 2 inches for diameters through 9 inches and 4 inches for diameters 10 inches through 60 inches.

Pipe-to-pipe and pipe-to-fitting connections in diameters above 60 inches are made by ductmate joints.

Round duct joints in diameters through 60 inches shall be assembled and sealed as follows:

Approved sealer equal to "Hard Cast" shall be applied to the coupling and fittings. After the joint is slipped together, sheet metal screws are placed 1/2 inch from the joint bead for mechanical strength. Sealer is then applied to the outside of the joint, extending 1 inch on each side of the joint bead and covering the screw heads. Plastic backed tape is immediately applied over the wet sealer.

The duct sealer must be specifically formulated for the job of sealing the field joints for high-pressure systems. The sealer shall be compatible with plastic-backed duct tape so the two shall cure and bond together. Samples of sealer and tape and the specification data sheets shall be submitted to the Engineer for approval.
Flanged joints shall be sealed by Neoprene Rubber Gaskets.

Access Doors and Panels:

Access doors shall be provided in fan rooms where shown on drawings or noted herein. Doors shall be double thickness with sheet metal on two sides and, where installed in insulated duct or plenum, shall be insulated the same thickness as specified for the duct or plenum. Doors shall be 18-gauge galvanized steel gasketed with sponge rubber. Frames shall be further reinforced with 1-1/2 x 1-1/2 x 1/8-inch galvanized

steel angles where required for structural strength. Two hinges shall be provided on doors up to 24 inches in the largest dimension and three hinges for doors 25 inches and larger. A clear plexiglass window (double in insulated duct) a minimum of 4-1/2 x 6 inches shall be installed in all doors. Two 2-way latches shall be installed for each door. Access doors shall be provided where shown on drawings and shall be 24 inches x 72 inches unless otherwise noted.

All access doors less than 4 square feet in area shall be made with Ventlock series 100 latches, hinges, and gasketing; doors from 4 to 8 square feet in area shall be made with series 200; doors larger than 8 square feet or high-pressure doors larger than 4 square feet shall be equipped with series 300 latches, hinges, and gasketing.

All access doors which penetrate a fire rated floor, wall or ceiling, shall have an equivalent rating.

Closure Collars:

A duct ending at a wall or partition shall have the edge turned back to form a closure collar and flanged tight to the wall or partition so that no sharp or ragged edge appears.

Exposed Round and Oval Low-Velocity Duct:

All joints and fittings shall be sealed with thermo-fit duct band by Raychem or approved equal. Contractor shall take care to insure that all joints and fittings are neat in appearance.

Flashing:

Where ducts pierce roof construction, the flashing shall be provided as part of this section and shall be as detailed in the SMACNA manuals. Flashing shall be welded to ducts.

The fan bases and duct opening bases on the roof shall be constructed by this Contractor as shown on the drawings. The base shall be constructed to fit the equipment approved for construction. This Contractor shall construct and install a 32-ounce inverted copper pan over the wood bases to act as a counterflashing and weatherproof hood for the base. All openings through the pan for fan mounting shall be sealed weathertight with lead washers. Details are given on the drawings.

Test Holes in Ductwork:

Test holes for testing air quantities in ducts shall be installed at locations to be specified by the Balancing Contractor. Rubber stoppers shall be provided for closing the test holes. Where these holes are installed in insulated ductwork, a removable plug of approved insulation material shall be provided.

Additional ports are to be installed in locations determined by the Architect or his representative.
Instrument ports shall be die cast with screwed cover for the insulation thickness specified. Neoprene gasket type shall be equal to Young No. 110. Ports shall be located outside of the plenum with 20-gauge sheet-metal sleeve of the same size as the port opening, passing through insulation where ducts have interior insulation.

Elbows:

Radius type elbows shall be used wherever possible. Radius elbows shall have a center line radius of at least 1.5 times the duct width. Short radius elbows will not be allowed. Square elbows may be used if

they are provided with turning vanes. No turning vanes or short radius elbows shall be allowed in medium pressure ductwork.

Branch Takeoffs:

Expanded throat takeoffs shall be used for all branch takeoffs unless shown otherwise on the drawings. An opposed blade volume damper with locking quadrant shall be provided at each branch takeoff. Where dampers are not accessible for adjustment from above, Young No. 315 or Ventlock 666 concealed ceiling regulators with adjustable chrome-plated covers shall be provided.

Wall Penetrations:

All ducts penetrating structural or architectural walls shall be sealed air and sound tight as specified in Section 230100, Mechanical General Requirements.

Dimensions:

Ducts, unless otherwise approved, shall conform accurately to the dimensions indicated on the drawings, and shall be straight and smooth on the inside with joints neatly finished. All duct sizes are net free inside dimensions. Acoustically lined ducts shall have outside dimensions increased as required to accommodate the acoustic lining specified and still maintain the free area inside dimensions shown on the drawings.

Field Verification:

No ductwork shall be fabricated without first field verifying that the available space under the actual job conditions will permit installation of the ductwork without structural of other conflicts.

Duct Cleaning:

Before ducts are insulated and before the ceiling is installed and final connections made to the terminal boxes, the fans shall be operated at full capacity to blow out any dirt and debris from the ducts. The full capacity of the fan shall discharge into the duct. If it is not practical to use the main supply blower for this cleaning, the ducts may be blown out in sections by a portable fan. After the ducts have been cleaned and initially pressure tested, the final connection shall be made to the terminal boxes.

Temperature Control Dampers:

This Contractor shall install all temperature control dampers furnished and as directed by the Temperature Control Contractor.

SHEET METAL SPECIALTIES:

Flexible Connections:

This Contractor shall provide flexible connections not less than 4 inches wide, constructed of heavy, waterproof, woven plastic-coated glass fabric at the inlet and outlet connections of each fan unit, securely fastened to the unit and to the ductwork by a galvanized iron band, and provided with tightening screws. Corners shall be sewn tight shut. The connection shall be 20-ounce Ventfab.

Volume Dampers:

Opposed-blade balancing dampers (OBD) to 12 inches by 36 inches: Dampers used in low-velocity branch ducts to control the volume or air flow shall be Young No. 817 volume control dampers. An operating head shall be placed on the side of the duct and shall be locked in position by a set key where the damper is accessible. Where the damper is not accessible, Young No. 817A or 817B volume control damper, consisting of an end bearing or miter gear, coupling, 3/8-inch square shaft, and a 31 x 3/8 inch regulator for operating the unit from suspended ceiling shall be provided.

Opposed-blade balancing dampers (OBD) larger than 12 inches by 36 inches: (Air Balance type AC114) opposed-blade damper of 14-gauge galvanized steel with locking quadrant shall be used or Aerolite, Ruskin or Louvers and Dampers.

Damper Regulators:

All volume dampers and splitter dampers in exposed ductwork shall be provided with Ventlock No. 640 or Young No. 443 damper regulators. Each volume damper and splitter damper concealed above an inaccessible ceiling, etc., shall be provided with a shaft extended through the ceiling, to which shall be attached a chrome-plated Ventlock No. 666 concealed damper regulator. No. 680 Ventlock miter gears shall be used where necessary.

Belt Guards:

Belt guards shall be fabricated and installed. Guards shall be constructed of 10-gauge wire, 1-inch mesh in 1-1/2-inch angle-iron welded frames. All guards shall be provided with an opening for a tachometer and shall be either the split type or easily removable for belt repair. The guards shall be anchored securely to the floor or walls to prevent any vibration.

Turning Vanes:

Turning vanes shall be furnished and installed in all 90-degree turns in all supply, return, mixed and fresh air ducts, and elsewhere as shown on the drawings. Install turning vanes in all exhaust ductwork except grease hood exhaust ductwork. Material of turning vanes shall match ductwork. Vanes are to be single blade, of size, spacing, gauge, and fabrication in accordance with SMACNA recommendations.

Ducts at Masonry:

Where ducts are shown connecting to masonry openings along edges of all plenums at floors and walls, a continuous 2 x 2 x 3/8-inch galvanized angle iron shall be provided. The angle iron shall be bolted to the construction and made airtight to the construction with caulking compound. Sheet metal at these locations shall be bolted to the angle irons.

V-Belt Drives:

V-belt drives of canvas and rubber construction of approved manufacturer shall be provided for all fans. V-belt drives shall have matched belts adjusted to drive the apparatus properly and to prevent slippage and undue wear in starting. Drives shall be designed for 150 percent of the specified motor nameplate rating. Drives for fans shall be Browning and Woods or an approved equal. Complete data on all drives must be submitted for approval. Drives must provide for the fan operating at midrange when at specified performance. At the completion of balancing, each drive shall be checked, and, if the fan is not operating near midrange, the V-belt drive shall be replaced with a suitable drive. Provide only "A", "B", or "C" Section drives. "3V" and "5V" are not acceptable. Provide variable pitch on all drives up to and including 10 hp. Larger horsepower drives shall be provided with fixed pitch sheaves and changed as

necessary by the balancing contractor. The cost of the new sheaves shall be borne by the Fan Manufacturer.

Duct Insulation:

All rectangular low-pressure supply air, return air, mixed air, and fresh air ducts shall be lined with 1 inch of fiberglass insulation securely butted or lapped and sealed. Insulation shall be Manville Standard Linacoustic 1-1/2 pound density with flame spread rating of 0-25 and smoke of 0-50. Duct liner shall have an NRC rating of 0.75 and a thermal conductivity (k factor) of 0.26 BTUH/In-ft^2. Duct dimensions shall be increased 2 inches on each side from those shown on drawings to accommodate insulation. Insulation shall be attached with Graham pins or stick slips applied not less than one for each 2 square feet of insulation. The insulation shall be applied to the sheet metal with a fire-retardant mastic on not less than 50 percent of the surface. The insulation shall be further held in place with mechanical fasteners spaced on not greater than 1-foot 0-inch centers. Side pieces of the duct lines shall be cut to lap inside the top and bottom pieces. All interior joints shall be painted to a smooth surface and all edges shall be coated with a fire-resistant mastic. The tops of all fasteners shall be coated with the same mastic. Exhaust ducts shall not be lined

INSTALLATION CHECK:

See Section 230100, paragraph "Installation Check".

EQUIPMENT:

Registers, Grilles, and Diffusers:

Registers, grilles, and diffusers of the sizes shown on the drawing and described herein shall be furnished and installed. All grilles, diffusers, and registers shall be complete with frames with rubber gaskets suitable for the area and wall construction where shown on the drawings. All registers shall be complete with a key-operated, opposed-blade dampers integral with the grilles. Ceiling diffusers shall be complete with opposed-blade dampers and equalizing grids.

Finish for all registers, diffusers, grilles, etc., in finished ceilings shall be off-white unless otherwise selected by the Architect. The successful supplier shall submit color samples to the Architect for his selections before the order is placed. All registers and grilles at exposed ductwork shall be aluminum. All data shall be certified, and all tests shall be performed in accordance with the requirements of the Air Diffusion Council. For convenience and to establish quality and function, manufacturers and their model numbers are used herein and on the drawings. Items for air distribution shall be Krueger, Tuttle & Bailey, Titus, J&J or Anemostat, Nailor and Hart. See plans for types.

See plans for schedules.

Temporary Filters:

Before any of the fan systems are operated, the Contractor shall provide and install in all filter framing systems one set of high-velocity disposable filters.

Filters shall be polyester media with scrim backing encased in a cardboard frame with bottle-cap material on the air entering and leaving side. Filters shall be Roto-Aire Model P-H23232, AAF, Continental, or Air Guard, Final filters, and prefilters shall be installed prior to air balance.

Flexible Duct (Low Pressure):

Flexible duct connections from the main trunk ducts to diffuser boots shall be furnished and installed as shown on the drawings. Flexible ducts shall contain a full inner liner, 1 inch of insulation, vapor barrier, and compression fittings on both ends. Flexible ducts shall connect to trunk duct with spin-in fittings with insulation guard and extractor. A balance damper with locking quadrant will be provided downstream of take-off from trunk duct. Flexible ducts shall be Genflex SLR-25 with spin-in fittings or Wiremold, or Flexmaster.

Ducts shall conform to the requirements for Class I connectors when tested in accordance with "Standard for Factory Made Air Ducts Materials and Air Duct Connectors" (UL 181). Ducts shall also pass the 15 minute U.L. flame penetration test as specified in the UL 181 Standard.

Roof-Mounted Centrifugal Domed Exhaust Fan:

Roof-mounted exhaust fans of the capacity shown on the drawings shall be furnished and installed. Fans shall be belt or direct driven as shown on the plans, complete with backdraft dampers and spun aluminum domed housing. Blower shall be non-overloading backward inclined. The motor and bearing shall not come into contact with the discharge air and shall be readily accessible without removal of fan or housing from location. A disconnect switch and self-flashing roof curb shall be supplied with fan. Fan shall be complete with insect screen. Provide a variable speed controller for balancing direct drive fans. Fans shall be Penn or equal of Jenn, ACME, Cook, Greenheck.

Ceiling Exhaust Fans:

Ceiling type exhaust fans of size and capacity shown on drawings shall be furnished and installed. Fans shall be direct drive of rpm shown and shall be complete with fan housing, inlet grille, backdraft damper and motor. Noise level shall not exceed 3.8 sones. Air quantities shall be certified by AMCA. Fans shall be Penn, Greenheck, or Cook. Duct shall be extended to roof or wall and a roof or wall cap shall be provided as required. Provide a fan speed controller for balancing contractor to use to set cfm’s.

END OF SECTION 23 0800

SECTION 23 0900 – AUTOMATIC TEMPERATURE CONTROL SYSTEM

PART ONE - GENERAL

SCOPE OF WORK

The Automatic Temperature Control (ATC) contractor shall provide a new, open protocol, web based, direct digital automatic control system to serve the entire new addition and systems related to new addition.

The scope of work shall include all labor, material, and equipment necessary to complete the temperature control work for the entire project.

The Contractor under this heading shall furnish and install a complete electric, electronic and direct digital temperature control system as specified.

This system shall include but not be limited to controls and equipment as hereinafter specified:

Automatic Temperature Control Dampers
Economizers
Domestic Hot Water Recirculating Pumps
Exhaust Fans
Packaged DX Cooled, Gas Fired Rooftop Units
Automatic Temperature Control Valves
Pumps
Coordination with Ice Rink
Refrigeration System

The Contractor shall carefully review all notes, coordination schedules, and drawings for work required under this section of the specification.

The Contractor shall carefully coordinate the rooftop unit controls and ascertain that the necessary relays, etc, provided with the rooftop unit is compatible with the control scheme. Any difficulties and or conflicts shall be immediately be brought to the engineer's attention in writing during the bidding period. Once the bidding period is over, the ATC contractor shall be responsible for any additional controls necessary for a complete control system as described herein.

Provide test equipment. Install and monitor as described under "Test Run", Section 230100.

Copies of the software shall be provided for remote monitoring and control of ths systems.

The controls contractor shall make a technician available at all times while the commissioning agent is reviewing 100% of the mechanical equipment after the system has been tested and balanced by the test and balance contractor prior to the completion of the project.

VFD for ATC Control

The ATC Contractor's scope of work also includes providing and installing the variable frequency drives for fans and pumps.

The VFD's installation, harmonic mitigation, and associated equipment coordination and interface shall be provided by the ATC contractor. Mounting VFD and connecting 4-20mA control signal shall be by the ATC contractor. Power wiring to and from the VFD to the motor shall be by the Electrical Division

WORK INCLUDED

Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

Provide a comprehensive operator and technician training program as described herein.

Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media.

Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

SYSTEM DESCRIPTION

A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2001, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as AC units and Exhaust fans etc. and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

Operator's Terminal (OT):

The Operator's Terminal shall be located as directed by engineer. Furnish 1 PC based terminal / work-station and table. Each of these work-stations shall be able to access all information in the system. Locate in new boiler room or as directed by engineer. Work-station information access shall use the BACnet Protocol. Communication shall use Annex J of ASHRAE Standard 135-95. Local connections of the workstation shall be on ISO 8802-3 (Ethernet). Remote communications shall use either the BACnet Point to Point Physical/Data Link Layer Protocol or IP over Point to point(PTP).

The operators terminals shall allow access to all information of the DCP which it is connected to as well as the information and programs of all DCP's in the entire building. The operator’s terminals shall display all data in full English language format. A minimum of three levels of operator access shall be provided. Level one shall allow retrieval of information only. Level two shall permit an operator to command points. (i.e. adjust setpoints, start/stop etc) The third level shall allow the operator to write and edit DDC Programs, assign passwords etc. Numeric or alpha-numeric coding requiring the use of look-up tables shall not be acceptable. The screen shall display menus that allow the operator a choice of options when requesting information or commanding a point or group of points. When the operator enters a character or answers a menu question, the system shall prompt him to enter the next requested menu choice and shall repeat the format until the command has been accepted or the report has been generated. The system shall automatically re-display the main menu allowing the operator to continue operation or exit the system.

An alarm/report printer shall be provided and installed adjacent to the CRT. The printer shall be connected directly to the network, independent of the CRT, and shall log all system alarm. In addition, the printer shall be used as a report printer for all reports requested through the CRT with keyboard.

A telephone modem shall be supplied and installed by the ATC Contractor. The modem shall allow communication from the DDC Controller to the ATC Contractors office for system troubleshooting, monitoring, and program changes as may be required during the warranty period. All hardware, software, and cables shall be provided and installed as part of this contract. A telephone line and RJ11 phone jack shall be provided by the owner at the location of the DDC Control Panel in the mechanical room. The modem shall operate on standard voice grade, dial-up phone lines.

GRAPHICAL USER INTERFACE

The color graphic terminal shall be driven by software which displays all information in a graphical format. The operator shall access any information via a command prompted, mouse driven interface. The operator shall be able to penetrate to any level of desired system information without being required to enter any commands from the keyboard.

The color CRT shall continuously display the present operator, local site connected to, number of total alarms for the system and total unacknowledged alarms. A section of the screen shall be dedicated to displaying the last reported alarm.

All system commands shall be graphically displayed using iconic, pull-down, pop-up or graphical data entry templates. Each command selection shall display an advisory description of the commands operation to inform the operator of the expected result.

Pop-up windows shall be used to display groups, points and other pertinent information where a variety of items are available to choose from. This feature shall be context sensitive when a user/operator requires help during a particular function request.

Graphics shall be provided for all mechanical, electrical and plumbing systems.
All system commands shall be graphically displayed using iconic, pull-down, pop-up or graphical

GRAPHICAL USER INTERFACE SOFTWARE (GUI):

The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously.

Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

A gallery of HVAC and automation symbols shall be provided, including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and symbols. The user shall have the ability to add custom symbols to the gallery as required.

Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.

Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.

Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

Schedule times will be adjusted by mouse command using a graphical slider, without requiring any keyboard entry from the operator.

Holidays shall be set by using a graphical calendar.

Commands to start and stop binary objects shall be done by mouse command from the pop-up menu. No entry of text shall be required.

System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

Create, delete or modify control strategies.

Add/delete objects to the system.

Tune control loops through the adjustment of control loop parameters.

Enable or disable control strategies.

Generate hard copy records or control strategies on a printer.

Select points to be alarmable and define the alarm state.

Select points to be trended over a period of time and initiate the recording of values automatically.

On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.

All system documentation and help files shall be in HTML format.

Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full

screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and unacknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

All application controllers for every terminal unit (AC) and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller via BACnet LAN.

Room sensors shall be provided with digital readout that allow the user to view room temperature, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode.

APPROVED MANUFACTURERS

The approved control systems are Schneider Electric DDC, Alerton Technologies, Staefa, Trane, or Honeywell.

The approved controls contractors:
- Utah Controls/Yamas
- Atkinsen Electronics
- ATC Contractors, Inc.
- Trane
- Honeywell Branch Office

QUALITY ASSURANCE

Responsibility: The supplier of the ATC System shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished.

Component Testing: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. Each and every controller, sensor, and all other DDC components shall be

individually tested by the manufacturer prior to shipment.

Tools, Testing and Calibration Equipment: The ATC supplier shall provide all tools, testing, and calibration equipment necessary to ensure reliability and accuracy of the system.

REFERENCE STANDARDS

The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof , shall govern design and selection of equipment and material supplied:

Engineers (ASHRAE).
ANSI/ASHRAE Standard 135-2001, BACnet.
International Building Code (IBC), including local amendments.
UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
National Electrical Code (NEC).
FCC Part 15, Subpart J, Class A

City, county, state, and federal regulations and codes in effect as of contract date.

Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

SUBMITTALS

Drawings

The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.

Drawings shall be submitted in the following standard sizes: 11” x 17” (ANSI B).
Eight complete sets (copies) of submittal drawings shall be provided.
Drawings shall be available on CD-ROM.

System Documentation

Include the following in submittal package:

System configuration diagrams in simplified block format.

Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.

Complete bill of materials, valve schedule and damper schedule.

Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.

Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.

For all system elements—operator's workstation(s), building controller(s), application controllers, routers, and repeaters,—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.

Provide complete description and documentation of any proprietary (non- BACnet) services and/or objects used in the system.

A list of all functions available and a sample of function block programming that shall be part of delivered system.

WARRANTY

Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.

This warranty shall apply equally to both hardware and software.

OPERATOR TERMINAL

The operator terminal / work-station shall consist of the following:
Personal Computer: Furnish IBM compatible PCs. The operator's PC shall have a minimum capability of the following:

The CPU shall be a minimum of an Intel and operate at a minimum of 4M, VT, 1333MHZ, FSB 2.66 GhZ.
Core 2 Duo processor.
A minimum of 2.0 GB of RAM.
One 1.44 Megabytes 3.5 inch diskette drive.
16X CD ROM drive.
80 Gigabyte hard disk with a minimum access time of 3.0 GB/s shall be provided.
A two button optical mouse with scrolling wheel will also be provided.
A 17" Dell, ultra sharp monitor.

Furnish all required serial, parallel, and network communication ports, and all cables for proper system operation.

Windows XP 2000
Energy Star 4.0 Category B
Integrated Video, Intel GMA3100 video Card
8X slim line DVD-Rom, Cyber link power DVD removable media storage
Speakers

SYSTEM SOFTWARE

Furnish the following applications software for building and energy management. All software

applications shall reside and run in the system controllers. Editing of applications shall occur at the operator work-station.

System Security

User access shall be secured using individual security passwords and user names.

Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.

User logon/logoff attempts shall be recorded.

Scheduling

Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to ten (10) events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

Weekly Schedule, Exception Schedules, Holiday Schedules, Optimal Start/Stop

Alarm Reporting

The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate work-stations based on time and other conditions. An alarm shall be able to start programs, be logged in the event log, printed, generate custom messages graphics.

Remote Communications

The system shall have the ability to dial out in the event of an alarm. Receivers shall include PC Workstations, and Alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be ably to remotely access and operate the system using dial up communications in the same format and method used on site.

PID Control

A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-wind-up shall be supplied. The algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs. The controlled variable, set-point, and PID gains shall be user-selectable. The set-point shall optionally be chosen to be a reset schedule.

Staggered Start

This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts shall be user- selectable.

Anti-Short Cycling

All binary output points shall be protected from short cycling. This feature shall allow minimum on-time

and off-time to be selected.

BUILDING CONTROLLER

All communication with operator workstation and all application controllers shall be via BACnet. Building controller shall incorporate as a minimum, the functions of a 3-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz), master slave token passing (MS/TP) LANs, a point-to-point (PTP – RS- 232) connection and modem.

Each MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).

The direct access port must be a female DB-9 connector supporting BACnet temporary PTP connection of a portable BACnet operator terminal at 9.6 to 115.2 Kbps over RS-232 null modem cable.

Building controller shall be capable of providing global control strategies for the system based on information from any objects in the system regardless if the object is directly monitored by the controller or by another controller. The program that implements these strategies shall be completely flexible and user definable. Any systems utilizing factory preprogrammed global strategies that cannot be modified by field personnel on-site or downloaded via remote communications are not acceptable. Changing global strategies via firmware changes is also unacceptable.

Programming shall be object-oriented using control function blocks, supporting DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be resident on workstation and the same tool used for all cont rollers.

Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator’s workstation or field computer.

Building controller shall provide battery-backed real-time (hardware) clock functions.

Controller shall have a memory needed to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative).

Global control algorithms and automated control functions should execute via 32-bit processor.

Controller installation shall include memory-free gel-cell battery providing ongoing power conditioning and noise filtering for operation data integrity. It shall provide up to 5 minutes of powerless operation for orderly shutdown and data backup.

BACnet Conformance

Building Controller shall as a minimum support Point-to-Point (PTP), MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Global controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:

Clock Functional Group
Files Functional Group

Reinitialize Functional Group
Device Communications Functional Group
Event Initiation Functional Group

Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).

Remote Communications: installation for the system. System shall be connected to the existing, countywide data network currently residing in the building. The county shall provide the IP addresses.

Provide Windows 2000 software for off-site computer that allows operator to view and change all information associated with system on color graphic displays. Operator shall be able to change all parameters in this section from off- site location including all programming of building controllers and all programmable application controllers including all terminal unit controllers.

Building controller shall have capability to call out alarm conditions automatically. If desired, controller may also send encoded message to digital pager. If an alphanumeric pager is in use by the operator, building controller shall be capable of sending a text or numeric string of alarm description. All building controllers connected to the local LAN shall be capable of calling out alarm messages through one or more shared modems connected to one or more of the building controllers on the local LAN.

Building controller shall have capability to call a minimum of 20 different phone numbers. Numbers called may be controlled by type of alarm or time schedule.

Owner shall provide standard voice-grade phone line for remote communication function.

Building controller and internal modem shall be capable of modem- to modem baud rates of 33.6 Kbps minimum over standard voice-grade phone lines. Lower baud rates shall be selectable for areas where local phone company conditions require them.

Schedules:

Each building controller shall support a minimum of 250 BACnet Schedule Objects and 250 BACnet Calendar Objects.

Logging Capabilities

Each building controller shall log as minimum 1000 trend logs. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator’s workstation.

Logs may be viewed both on-site or off- site via remote communication.

Building controller shall periodically upload trended data to networked operator's workstation for long term archiving if desired.

Archived data stored in database format shall be available for use in third party spreadsheet or database programs.

Alarm Generation:

Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

Each alarm may be dialed out as noted in paragraph 2 above.

Alarm log shall be provided for alarm viewing. Log may be viewed onsite at the operator's terminal or off-site via remote communications.

Controller must be able to handle up to 1500 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.

TERMINAL UNIT APPLICATION CONTROLLERS (AC UNITS)

Provide BACnet application controller (ALER-T7350-BT-3H3C) for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

BACnet Conformance

Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:

Files Functional Group
Reinitialize Functional Group
Device Communications Functional Group

Please refer to section 22.2, BACnet Functional Groups in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

Standard BACnet object types supported shall include as a minimum– Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K

thermistors, 0–5 VDC, 4–20 mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

Application controller shall include support for intelligent room sensor (see Section 2.9.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

SENSORS AND MISCELLANEOUS DEVICES

All control devices shall be mounted a maximum of 24" above the ceiling.

Thermostats:

Thermostats for packaged rooftop units shall be provided, installed and wired by the ATC contractor. Thermostats shall be Low voltage type provided with automatic change over feature for both heating and cooling stages, seven day program with two starts and stops per day, and provisions for damper operators.

Vandal proof covers are not required in classrooms and offices. In areas where there is little supervision remote sensors with thermostats mounted up by the rooftop unit is required. Remote sensor is to have a override button which sits in an outlet box covered with vandal proof guard.

Provide remote sensor in the Activity and Ice Areana. Locate thermostat in mechanical room.

Aquastat:

Provide, install, and wire aquastats in domestic water return piping for controlling circulation pumps.

Temperature Sensors

All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches about finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

Intelligent Room Sensor with LCD Readout

Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.

The Intelligent Room Sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in Fahrenheit or Centigrade.

Override time may be set and viewed in half- hour increments. Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.

ENCLOSURES

All controllers, power supplies and relays shall be mounted in enclosures.

Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

Enclosures shall have hinged, locking doors.

Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8” thick sized appropriately to make label easy to read.

ATC DAMPERS

The ATC Contractor shall furnish all automatic control dampers and all damper actuators. The Sheet Metal Contractor shall transition all ductwork to the dampers. All modulating dampers shall be parallel type with the blade width shall not exceed 8 inches. Dampers shall have butyl rubber blade and end seals with adjustable linkage to provide equal percentage characteristics. Linkage to be mounted inside channels of the frame. Bushings to be oil impregnated sintered iron turning in nylon bearings. Frame of the damper to be drilled by the damper manufacturer to accommodate direct mounting to the operators. All operators shall be mounted external of the airflow, and be easily accessible for services. Leakage to be less that 1% with 2000 FPM and 6” w.g. static across the dampers. All dampers submitted shall show engineering data to substantiate above specifications are met. Dampers shall be Ruskin CD50, Johnson D-1100, D-1200, D-1300 Series. Honeywell D643 Series (not LS) or Delta VOASS.

The Temperature Control Contractor furnished all automatic dampers. The Sheet Metal Contractor under the supervision of the Control Contractor shall install them.

ATC VALVES

ATC contractor shall furnish a motorized, spring return, 2-way or 3- way ball valve of proper size to be mounted in the supply water piping prior to each VAV reheat coil. Actuators shall be compatible with the vav box controls, and shall provide modulating action. Mounting of each ATC valve shall be by the installing Mechanical Contractor.
Automatic valves shall be available in either flanged or screwed connection. Valves 2" and smaller shall

be screwed and larger valves shall be flanged. Screwed valves shall be rated at 150 psi and have cast iron, brass or steel bodies. Flanged valves shall be rated at 125 psi minimum and shall have cast iron or steel bodies. All two-way valves, either normally open or normally closed, shall be furnished with modulating plugs which produce an equal percentage flow characteristic. Three-way mixing valves shall be furnished with equal percentage plugs. Water valves shall be sized for 3-5 psi P.D.
Valves shall be Belimo or Honeywell.

Smoke Detectors:

Duct smoke detectors shall be furnished, installed and wired by the Electrical Division. Duct detectors shall be wired to the Fire Alarm Panel by the Electrical Division.

Fan shutdown shall be wired to the local motor starter or VFD by the Electrical Division.

EXAMINATION

Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

Notify the owners' representative in writing of conditions detrimental to the proper and timely completion of the work.

Do not begin work until all unsatisfactory conditions are resolved.

INSTALLATION (GENERAL)

Install in accordance with manufacturer's instructions.

Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

LOCATION AND INSTALLATION OF COMPONENTS

Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from owner’s representative prior to installation.

All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.

Identify all equipment and panels. Provide permanently mounted tags for all panels.

INTERLOCKING AND CONTROL WIRING

Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 26 and all national, state and local electrical codes.

Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough- in.

Provide auxiliary pilot duty relays on motor starters as required for control function.

Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.

All control wiring to be installed in raceways.(3/4" min) NO EXCEPTIONS.

DDC OBJECT TYPE SUMMARY

Provide all database generation.

Displays

System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.

Run Time Totalization

At a minimum, run time totalization shall be incorporated for each monitored supply fan, exhaust fan and pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.

Trendlog

All binary and analog object types (including zones) shall have the capability to be automatically trended.

Alarm

All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.

Database Save

Provide back-up database for all stand-alone application controllers on disk.

FIELD SERVICES

Prepare and start logic control system under provisions of this section.

Start- up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum,

off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for 1 year or as specified.

AS BUILT DOCUMENTATION REQUIRED

5 sets of asbuilt documents are required

TRAINING

Provide application engineer to instruct owner in operation of systems and equipment.

Provide system operator's training to include (but not limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of 3 persons.

Provide on-site training above as required, up to 16 hours (in r hour sessions) as part of this contract.

DEMONSTRATION

Demonstrate complete operating system to owner's representative.

END OF SECTION 23 0900

SECTION 23 0901 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

RELATED DOCUMENTS

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

SUMMARY

This Section includes control sequences for HVAC systems, subsystems, and equipment.

Related Sections include the following:

Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

DEFINITIONS

DDC: Direct digital control.

SEQUENCE OF CONTROL

SEQUENCE OF OPERATION:

GENERAL:

All supply, relief and exhaust fans shall be monitored through the DDC Control System. The run time of all monitored motors shall be available thru the DDC controls. Maintenance alarms messages shall be programmed at a specific run time as designated by the system operator.

A discharge air sensor shall be installed for every rooftop unit and value made available to the ATC system for monitoring and display.

Duct smoke detectors shall be provided, installed and wired by the Electrical Division contractor. The duct smoke detectors shall be connected to the building fire alarm system by the Electrical Division.

A manual reset low limit thermostat will be provided and installed downstream of the heating coil in RTU-1 (VAV unit). It will be wired to the fan starter and wired in series with the fire alarm shutdown wiring. When the setting of the low limit thermostat is exceeded, the fan will shut down, the outside air dampers will close, and the new hot water circulating pump serving the new addition (if present) shall be enabled. A low temperature alarm will be generated at the FMS console.

All DDC outputs shall be set to a failsafe value on power loss, CPU failure or loss of controlling sensor.

All fan shutdown functions shall operate as described above regardless if the VFD’s or motor starter is in ”Auto“, ”Hand“, or “Bypass” position.

Although specific set points, time periods and reset values are listed in the sequence of operation, all values shall be changeable through the DDC system. The initial occupied/unoccupied schedules shall be as designated by the owner's representative.Fan status on the all supply, and exhaust fans shall be provided by a differential pressure switches connected across the fan. Status of all pumps except fractional horsepower and variable speed units shall have differential pressure switches connected across the pump.

A current sensitive relay may be used in place of the differential pressure switches, provided that the switching points can be set so that loss of fan belts or pumps couplings will activate the switch even if the motor is still operating.

All supply, and exhaust fans shall stop on power failure unless on emergency power. When power has been restored to normal for a minimum of two minutes, the fans shall restart at 30 second intervals (adjustable) in a predetermined sequence as directed by the owner's representative. This restart sequence shall be changeable by the operator.

The outside air and relief air dampers shall close on fan shutdown, unoccupied cycle, power failure, and activation of low limit thermostat.

Inputs and outputs required to meet the sequence of operation shall be provided, whether or not they are listed in the Input/Output schedule. All points listed in the I/O Point Schedule shall also be provided.

LOBBY AND CONNECTOR RTU-1 ROOFTOP UNIT :

This system consists of a packaged rooftop unit with variable volume supply fan, relief fan, economizer, gas fired heat, and DX cooling.

The rooftop unit shall be controlled through the ATC Control System. In the occupied mode the supply and return fans shall operate continuously, and the outside air damper shall open to minimum position.

Manual reset high static switches shall be provided in the discharge of the supply fans. The initial set point shall be +3.5" w.c. for the supply fan discharge. Final adjustment shall be made as needed during system test and balance.

A space static pressure transmitter will, modulate the relief air dampers and relief fan to maintain space static pressure at +0.05" w.c.

A duct static pressure transmitter located two thirds the distance down the longest duct run shall, through the DDC Control System, modulate the supply Variable Frequency Drive to maintain duct static pressure set point. The initial set point shall be 1" w.c., and shall be adjusted during system test and balance to the required set point.

A temperature sensor located in the discharge air shall, through the DDC Controller, modulate the outside, return, and relief air dampers, relief fan and cycle the stages of heating and cooling to maintain discharge air set point as reset by the warmest space temperature according to the following schedule:

DISCHARGE AIR TEMPERATURE	WARMEST SPACE TEMPERATURE
55 DEG	SETPOINT +2 DEG
65 DEG	SETPOINT -1 DEG

The discharge air temperature set point shall not be reset above 65 degrees or below 55 degrees.

Unit economizers shall modulate the outside air, return air, relief air dampers, relief fan and economizers in sequence to maintain unit discharge air set points. The economizer shall be enthalpy based and shall modulate the return air and outside air dampers to provide outside air for free cooling as required.

A carbon dioxide transmitter located in the return air shall, through the DDC Controller, adjust the minimum outside air damper position to maintain a maximum 800 ppm. CO2. A temperature sensor located in the mixed air shall, through the DDC Controller, override the control and modulate the outside air damper toward the closed position if the mixed air temperature drops below 50 degrees.

Both economizer packages and CO2 control shall be provided with the equipment.

The fans will be indexed manually or automatically, from the occupancy scheduling program, from occupied to unoccupied from the DDC system. In the unoccupied mode the fans will be off. If the space temperature drops five degrees below space temperature set point the unit will start and run until the unoccupied set points are satisfied. The outside air dampers will remain closed during unoccupied mode operation.

In the unoccupied mode the room space temperature set point will be 65 degrees in winter (outside air temperature below 75 degrees) and 80 degrees in summer (outside air temperature above 75 degrees).
In the unoccupied mode the equipment shall be off unless the unoccupied set point is not satisfied. In that case the equipment shall start the blower fan and cycle on long enough to satisfy the unoccupied set point. An override button on the thermostat shall return the equipment to the occupied mode for a certain period of time (adjustable).

Whenever there is a call for heat the new heating pump serving the vav reheat coils shall be started.

VAV BOXES:

A space temperature sensor shall, through the Application Specific Controller (ASC), modulate the VAV damper and reheat coil valve in sequence to maintain space temperature set point. The VAV Box minimum and maximum heating and cooling CFM shall be controlled by the ASC. The heating minimum shall be 30% of box flow and the cooling minimum shall be 30% of box flow. The heating maximum shall be 60% of box flow and the cooling maximum shall be 100% of box flow. If any space temperature cannot be maintained at the reduced minimum CFM, the fan system discharge air temperature set point shall be increased until all areas are at or above heating set point.

The VAV controller and inlet air flow sensor will be provided and installed by this contractor in the field.

HEATING HOT WATER CONTROL:

The existing heating system is controlled by the existing control system. The new heating hot water pump shall be started and stopped through the new DDC system. The pump shall be run whenever there is a call for heat at the new vav zones. Provide an aqua stat to prevent the new heating hot water pump from running if the existing heating water temperature is below 80 degrees.

TEAM ROOM AND ACTIVITY AREA ROOFTOP UNITS :

This system consists of packaged rooftop units. Each rooftop unit has a supply fan, relief fan, economizer, gas fired heat, and DX cooling.
The rooftop unit shall be controlled through the ATC Control System. In the occupied mode the supply and return fans shall operate continuously, and the outside air damper shall open to minimum position.

A space static pressure transmitter will, modulate the relief air dampers and relief fan to maintain space static pressure at +0.05“ w.c.

A temperature sensor located in space shall, through the DDC Controller, modulate the outside, return, and relief air dampers, relief fan and cycle the stages of heating and cooling to maintain space set point.

Unit economizers shall modulate the outside air, return air, relief air dampers, relief fan and economizers in sequence to maintain unit discharge air set points. The economizer shall be enthalpy based and shall modulate the return air and outside air dampers to provide outside air for free cooling as required.

A carbon dioxide transmitter located in the return air shall, through the DDC Controller, adjust the minimum outside air damper position to maintain a maximum 800 ppm. CO2. A temperature sensor located in the mixed air shall, through the DDC Controller, override the control and modulate the outside air damper toward the closed position if the mixed air temperature drops below 50 degrees.

Both economizer packages and CO2 control shall be provided with the equipment.

The fans will be indexed manually or automatically, from the occupancy scheduling program, from occupied to unoccupied from the DDC system. In the unoccupied mode the fans will be off. If the space temperature drops five degrees below space temperature set point the unit will start and run until the unoccupied set points are satisfied. The outside air dampers will remain closed during unoccupied mode operation.

In the unoccupied mode the room space temperature set point will be 65 degrees in winter (outside air temperature below 75 degrees) and 80 degrees in summer (outside air temperature above 75 degrees). In the unoccupied mode the equipment shall be off unless the unoccupied set point is not satisfied. In that case the equipment shall start the blower fan and cycle on long enough to satisfy the unoccupied set point. An override button on the thermostat shall return the equipment to the occupied mode for a certain period of time (adjustable).

EXHAUST FAN CONTROL:

The exhaust fans shall be controlled as indicated on the exhaust fan schedule.

DOMESTIC HOT WATER CONTROL:

The domestic hot water heaters shall be furnished complete with controls.

Each domestic hot water recirculating pump shall run during occupied hours.. All domestic hot water recirculating pumps shall be locked out during unoccupied times.

ICE RINK ROOFTOP UNIT FAN SYSTEM RTU’s:

This system consists of packaged rooftop units. Each rooftop unit has a supply fan, relief fan, economizer, gas fired heat, and DX cooling.

The rooftop unit shall be controlled through the ATC Control System. In the occupied mode the supply and return fans shall operate continuously, and the outside air damper shall open to minimum position. A space static pressure transmitter will, modulate the relief air dampers and relief fan to maintain space static pressure at +0.05“ w.c.

A temperature sensor located in space shall, through the DDC Controller, modulate the outside, return, and relief air dampers, relief fan and cycle the stages of heating and cooling to maintain space set point.

Space temperature set point will be 55 degrees in winter (outside air temperature below 75 degrees) and 60 degrees in summer (outside air temperature above 75 degrees).

Unit economizers shall modulate the outside air, return air, relief air dampers, relief fan and economizers in sequence to maintain unit discharge air set points. The economizer shall be enthalpy based and shall modulate the return air and outside air dampers to provide outside air for free cooling as required.

A carbon dioxide transmitter located in the return air shall, through the DDC Controller, adjust the minimum outside air damper position to maintain a maximum 800 ppm. CO2. A temperature sensor located in the mixed air shall, through the DDC Controller, override the control and modulate the outside air damper toward the closed position if the mixed air temperature drops below 50 degrees.

Both economizer packages and CO2 control shall be provided with the equipment.

The fans will be run in an occupied mode continuously to maintain a consistent ice area environment.

Provide humidity and temperature sensors and transmitters located in the joist space of the ice area. The sensors will be used to calculate dew point temperature. Three humidity transmitters, located at the bottom of the joists with three temperature sensors will be used to calculate the dew point temperature.

In the occupied mode, if the joist temperature is less than 10 degrees warmer than dew point, the outside air damper will be modulated towards the open position and the discharge air temperature will be increased with a maximum space temperature of 65 degrees to provide dehumidification by increasing the quantity of outside air and raising the discharge air temperature. When the differential rises above 10 degrees, the normal space temperature control will be resumed.

END OF SECTION 23 0901

SECTION 23 0910 - REFRIGERATION AUTOMATION SYSTEM

GENERAL CONDITIONS:

GENERAL

Scope of work:

Refrigeration Automation System (RAS) Contractor shall provide:

A fully integrated Refrigeration Automation System (RAS), UL listed, incorporating direct digital control (DDC) for energy management, equipment monitoring and refrigeration system control.

The Refrigeration Automation System shall be provided by Frick and fully interface ATC webserver. The Refrigeration Automation System shall be installed, wired and certified by a representative of the Frick Distributor.

Complete control system to be DDC as specified herein.

All wiring, conduit, panels, for all DDC temperature controls.

All final electrical connections to each stand-alone DDC Controller. Provide power as required for all panels.

RAS Contractor shall be responsible for all electrical work associated with the RAS control system and as called for on the Drawings.

Perform all wiring in accordance with all local and national codes.

Install all line voltage wiring, concealed or exposed, in accordance with Division 16.

Electrical Contractor shall provide 120 volt, 20 amp circuits and circuit breakers from normal and/or emergency power panel for direct digital control systems.

Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers, and operator's workstations.

Heating/refrigeration Contractor provides:

All wells and openings for water and refrigerant monitoring devices, flow switches and alarms furnished by RAS Contractor.

All package unit control panels.

Electrical Contractor provides:

120 volt power to DDC Controller in Ammonia Plant.

General Product Description:

The refrigeration automation system (RAS) shall integrate multiple building functions including equipment supervision and control, alarm management, energy management and historical data collection.

The refrigeration automation system shall consist of the following:

Stand-alone DDC Controllers

Stand-alone Application Specific Controllers (ASC) (Provided with compressor package)

BacNET/IP interface to allow access to all points, set points, and schedules to web server interface provided by ATC contractor.

RELATED WORK:

Specified elsewhere:

Basic Refrigeration Requirements, Section 15650

Automatic Temperature Control System, Section 15900

QUALITY ASSURANCE:

Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

Install system using competent workmen who are fully trained in the installation of temperature control equipment.

Single source responsibility of supplier shall be the complete installation and proper operation of the RAS and control system and shall include debugging and proper calibration of each component in the entire system.

All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, and Governing Radio Frequency Electromagnetic Interference and be so labeled.

RAS shall comply with UL 916 and be so listed at the time of bid.

Design and build all system components to be fault-tolerant.

Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency.

Static, transient and short-circuit protection on all inputs and outputs.
Protect communication lines against incorrect wiring, static transients and induced magnetic interference.

Network-connected devices to be A.C. coupled or equivalent so that any single device failure will not disrupt or halt network communication.

All real time clocks and data file RAM to be battery-backed for a minimum 72 hours and include local and system low battery indication.

SUBMITTALS:

Submit 6 complete sets of documentation.

Manufacturer's Product Data:

All equipment components

Shop Drawings:

System wiring diagrams with sequence of operation for each system as specified.

Submit manufacturer's product information on all hardware items along with descriptive literature for all software programs to show compliance with specifications.

System configuration diagram showing all panel types and locations as well as communications network and workstations.

SYSTEM START-UP AND TESTING:

Provide Engineer-approved operation and acceptance testing of the complete system. The Engineer will witness all tests.

Field Test: When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Provide a detailed cross-check of each sensor within the system by making a comparison between the reading at the sensor and a standard traceable to the National Bureau of Standards. Provide a cross-check of each control point within the system by making a comparison between the control command and the field-controlled device. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power. Submit the results of functional and diagnostic tests and calibrations to the Engineer for final system acceptance.

Compliance Inspection Checklist: Submit in the form requested, the following items of information to the Owner's Representative and Architect/Engineer for verification of compliance to the project specifications. Failure to comply with the specified information shall constitute non-performance of the contract. The contractor shall submit written justification for each item in the checklist that he is unable to comply with. The Owner's Representative and the Architect/Engineer will initial and date the checklist to signify contractor's compliance before acceptance of system.

SERVICE:

General Requirements: Provide all services, materials and equipment necessary for the successful operation of the entire RAS system for a period of one year after completion of successful performance test. Provide necessary material required for the work. Minimize impacts on facility operations when performing scheduled adjustments and non-scheduled work.

Description of Work: The adjustment and repair of the system includes all computer equipment, software

updates, transmission equipment and all sensors and control devices. Provide the manufacturer's required adjustments and all other work necessary.

Personnel: Provide qualified personnel to accomplish all work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

SEQUENCE OF OPERATION:

OPERATING SEQUENCING FOR THE REFRIGERATION PLANT:

Refrigerant Flow:

Refrigerant (ammonia-R-717) will flow as a gas from the brine chillers to the compressors, where it is compressed and heated and is sent to the condenser (or to the heat recovery heat exchangers.) The condenser cools the gas where it changes to a liquid (at about 95°F) which flows down to a high pressure receiver. This vessel acts as a reservoir to supply the compressors with liquid refrigerant for oil cooling. At a preset level, controlled by an electronic level control, the liquid is released to a lower pressure (controlled pressure receiver) vessel where part of the liquid is flashed off to the compressors economizer port. This vessel also acts as a surge vessel holding any extra refrigerant in the system. From here the liquid ammonia will flow as required to the brine chiller where it will be flashed to about 33 psia or 5°F. In the brine chiller the refrigerant will evaporate as required to cool the brine as it flows thru the brine cooler bringing the heat from the floor and returning the now colder brine to the floor to make and maintain the ice.

Control Requirement:

It is the intention of the refrigeration controls to completely control the operation of the plant within the compressor room and will be supplied by the Refrigeration Automation System Contractor as specified under Section 15910. The RAS will monitor the operation of the compressors from the main control panel. The ice floor temperature which is the main control point will also be monitored and adjustable but only after a password access so that only the plant ice operator has access. All alarms will be monitored.

Ice and Overall Plant Controls:

The under ice temperature sensor will be a positive coefficient platinum sensor which will be wired to an electronic remote temperature control. This sensor will be inserted into a pipe well which is inserted in the floor between the ice floor piping and will initiate the startup of the lead ice floor brine circulating pump. The floor sensor will initiate the compressor operations if the brine pump is operating. The sensor will also open the suction solenoid valve at the chiller. The controls must ensure that the compressors will not operate unless one brine pump is running. The controls will switch to the lag ice floor brine circulating pump as manually selected by the operator or upon failure of the lead pump. The lead and lag ice floor brine circulating pumps for the rink shall not operate at the same time. The brine pump vfd will ramp up the brine pump to 100% speed on startup. Based upon the temperature control sensor difference between the set point the controls will modulate the brine pump vfd speed to maintain the set point.

The ice temperature should be adjustable from 10°F to 30°F by the Chief Operator of the plant.

There is a similar system to control the under floor brine heating pump. Normal operating temperature is a similar system to control the under floor brine heating pumps. Normal operating condition is to have

the pump run only when the plant is operating. The pump shall be started when the temperature in the under floor ground is about 37°F and shutting down when the ground reaches 39°F. When the pump starts the heat exchanger hot gas solenoid shall open. The pump shall continue to operate until it reaches its set point. After the set point is reached or the plant shuts down the solenoid will close.

Another similar system will control the snow melt system but the main operating device is a temperature sensor in the snow melt pit that will control the water temperature between 45°F low and 70°F high. Similar but different timing delays will be set. When the pit is below set point the pump shall be activated and the heat exchanger hot gas solenoid valve shall be opened.

The circulating pump for the DHW recovery exchanger shall be controlled by an aqua stat on the warm water tank. The pump will run until the set point is reached. When the pump stops the heat exchanger hot gas solenoid valve will close.

The circulating pumps for the pool recovery exchanger shall be controlled a temperature sensor in the pool return water piping upstream of the pool heat exchanger. When the pool return water temperature is below set point the pump will start and the three way valve shall modulate to maintain set point. When the pumps are running the heat exchanger hot gas solenoid valve shall be open. When the pump stops the heat exchanger hot gas solenoid valve will close.

The heat exchangers shall be staged on in the following priority:
Sub floor heating, snow melting pit, dhw, pool.

When no heat recovery is enabled, solenoid valves to DHW-1 and POOL-1 shall be closed and the 100 psig inlet pressure regulator will be open.

When heat recovery is enabled;
95 psig inlet pressure regulator controls higher pressure (excess gas to condenser)
Solenoid valves to DHW-1 and POOL-1 are open (only one at a time as determined by RAS controls) and the 100 psig inlet pressure regulator is closed.
Back pressure regulators to DHW-1 and POOL-1 maintain a minimum pressure (set at 75 psig) and 105 psig outlet regulator maintains minimum back reverse pressure.

<u>Compressor Controls:</u>

When the brine pump starts up and flow is established then the lead compressor starts. As the load increases the additional compressors will be staged on as most efficiently selected by the Frick controls. Compressor capacity will be added by whether the suction pressure of the plant is increasing and will be reduced by a suction pressure decrease.

All compressors when started will be unloaded. After starting and lubrication flow etc. has been established then the compressor will be set to load fully. As long as the compressor is required for the load it will operate fully loaded and when not required will unload fully and then stop. These controls are all by the compressors own control panel. Before the compressors will start again they will be unloaded if not already unloaded.

Any of the compressors can be operated manually provided a brine pump is running. The individual compressor control units will contain all the safety controls and operating controls for the compressor it is mounted on.

Each compressor has an R-717 oil cooler which utilizes condenser refrigerant from the high pressure receiver as the medium. There are not controls required on this system as the action is controlled by thermodynamic flow within the equipment.

Brine Chiller Controls:

The refrigerant control to the brine chiller is dual ammonia feed solenoids operated by an electronic liquid level sensor which senses liquid level in the chiller and will only operate the solenoids when the refrigeration compressors are operating.

Condensing System Controls:

The existing condenser system shall be controlled by a refrigerant discharge pressure sensing device in the compressor discharge line. When the pressure reaches a pre-set pressure (about 165 PSIG) a pressure switch will start the condenser water pump operating. As the pressure keeps rising the condenser fan motors will start one at a time. The reverse will be true for decreasing discharge pressure.

Overall Alarm System:

The refrigeration controls system shall include ammonia sensors and shall indicate alarms via audible and visual indications. An alarm horn in the refrigeration plant will signal alarm condition. A red light, mounted above the entry door from the building into the refrigeration plant will also signal an alarm condition. The refrigeration contractor shall wire these alarms as directed by Frick controls.

An ammonia refrigerant sensor, mounted in the refrigeration room in an appropriate location shall sense R-717 in the refrigeration room and reports this information to the RAS system.

The alarm system will have two levels of alarm - alarms to have the operator investigate conditions that are not normal and alarms that require immediate attention and will shut down the system.

All alarms will report to ATC provided web server via BacNET/IP interface.

Refrigerant Leak Alarm:

Ammonia leaks (two stages):

The first stage at 50 ppm of ammonia vapor will give a warning alarm to the DDC Control System.

The second stage at 1000 ppm which will turn on the ventilation system to maximum exhaust and give audible and visual warnings to plant operators that immediate attention must be paid to the plant.

A wall mounted line voltage thermostat shall cycle the exhaust fan if the space temperature rises above 80 degrees.

Whenever the exhaust fan is started the motorized intake damper shall open. When the fan is off, the damper shall close.

Shut Down Alarms:

Devices and wiring specified under shut down alarms shall be supplied and wired by RAS Contractor.

Very low suction pressure shut down
Very high discharge pressure shut down
Very high ice temperature
High refrigerant level in the brine chiller
No cooling water flow to the condenser
Plant power off.

Operator Investigation Required:

High brine temperature
Very low refrigerant level in the brine chiller
High condenser water temperature
Low water temperature in the heating exchanger
Low hot water flow in the heating exchanger
Any device or motor that the system is calling for that is not operating.
First stage ammonia alarm
Low level at thermosiphon

Emergency Shutdown and Ventilation Switches:

The emergency ammonia plant shutdown switch and emergency ventilation control switch shall be provided by the refrigeration contractor. Furnish, wire and install the emergency shutdown switch and emergency ventilation switch next to the door to the refrigeration plant. The emergency ammonia shutdown switch enclosure shall be of the break glass type, containing an emergency stop switch which, when activated will stop all refrigeration equipment, and generate an alarm at the central computer. The switch shall be compatible for a future interlock with an emergency generator. A second switch in another break glass type enclosure shall allow activation of the ventilation system, to purge the ammonia from the building. When activated the ATC dampers at the intake into the refrigeration plant shall open and the fan shall start.

END OF SECTION 23 0910

SECTION 23 0950 - VARIABLE FREQUENCY DRIVES

GENERAL

RELATED DOCUMENTS

The drawings and general provisions of this contract, including general and supplementary conditions and Division 1 specification sections, apply to work of this section.

Information contained on the drawings and/or schedules shall detail the additional specific requirements for the Variable Frequency Drive (VFD) system equipment.

SCOPE OF WORK

It is the intent of this specification to set the minimum acceptable requirements for the design, construction, installation, commissioning and vendor support requirements for the VFD systems herein specified.

The VFD installation, harmonic mitigation, and associated equipment coordination and interface shall be provided by the ATC Contractor. Mounting VFD and connecting 4-20mA control signal shall be by Division 23. Power wiring to and from the VFD to the motor shall be by Electrical.

CODE AND STANDARDS

The equipment supplied under this specification shall conform to the latest applicable codes and standards of the following:

1. NEC - (NFPA 70) - National Electric Code.
2. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
3. NEMA AB 1 - Molded Case Circuit Breakers.
4. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
5. IEEE Standard 519-1992 - Recommended Practices for Harmonic Control in Electrical Power Systems.
6. ANSI C37 - Standards for Circuit Breakers, Switchgear, Relays, Substations and Fuses.
7. ANSI C57 - Distribution, Power, and Regulating Transformers (includes Reactors).

The fully assembled VFD system shall carry the UL label certifying UL-508 standards. An equivalent safety labeling program by ETL or CSA documenting compliance with these industry standards shall be acceptable.

VENDOR QUALIFICATIONS

All vendors supplying equipment and/or services under this specification, shall pre-qualify and be listed in section 1.5.

Division 23 shall coordinate and assume system responsibility and compatibility between the various approved supplier's equipment and services required to meet these specifications.

Division 23 shall be responsible for the coordination with qualified vendors of equipment and services outside the scope of this specification (but required for the proper operation of the system) as listed in section 4.1.

ACCEPTABLE SUPPLIERS

The following VFD manufacturer's equipment have been pre-approved to meet the products section of this specification:

1. Toshiba Q Flow Saver.
2. ABB.
3. Mitsubishi
4. Honeywell
5. Siemens
6. Cutler 1
7. Danfoss

The following manufacturers have been pre-approved to meet the harmonic testing and documentation section of this specification:

1. Energy Management Corporation.
2. Power Quality Consultants.

HARMONIC TESTING

Harmonic testing must be performed by a manufacturer that is independent of the supplier.

Payment for the VFD materials and labor shall not be made until the harmonic testing has been completed and accepted.

SUBMITTALS

The following information shall be included with the bid package:

1. Description of equipment and tests included in bid to meet power quality requirements of section 3.1.
2. Qualifications and name of engineering and technical persons responsible for support and warranty on this project.
3. Extended warranty/service contract bid per section 4.4.B.

The following shall be included in the submittal package in the quantities required under the general provisions of this project:

1. Completed Data Sheet.
2. Set of outline drawings giving complete mounting and conduit entry and exit dimensions.
3. Set of complete electrical drawings for power and control wiring.
4. Detailed drawings of filter equipment and sample graphs and data to meet IEEE 519-1992 compliance for voltage and current distortion.
5. Manufacturer's literature giving detailed information of equipment being supplied including part numbers, model numbers and ratings.

The following compliance and approval forms shall be submitted for approval:

1. Sample installation approval form to comply with section 4.1.
2. Sample VFD system commissioning approval form to comply with 4.2A.

3. Sample VFD system training approval form to comply with 4.2B.
4. Sample VFD quality assurance program and sample factory test and certification report forms as required to meet section 2.5.

PART 2 - PRODUCTS

GENERAL

This portion of the specification outlines the overall fabrication, performance and functional requirements of VFDs supplied for positive speed control of standard NEMA design B induction motors.

It is the intent of this section to specify non-proprietary designs and hardware that assure modern "state of the art" equipment which provides a high level of performance and reliability for the greatest long term, total value to the owner.

SYSTEM DESCRIPTION

The VFD system shall be supplied as a complete, pre-integrated, stand-alone package produced by a single manufacturer regularly engaged in the production of same and who maintains full system support responsibility.

The VFD system manufacturer shall integrate all components and equipment required to meet these specification features and functions as a single UL (or equivalent) labeled system. Vendors providing equipment requiring panel shop or job site modifications or additions that would not be valid under the original equipment manufacturer's (OEM's) safety labeling will not be acceptable.

Pre-integrated equipment shall include but not be limited to incoming line filters, rectifier units, inverter units, control circuitry, operator interfaces, protective equipment, and other accessories and auxiliary items necessary to meet the highest standards for the type of service specified herein.

CONSTRUCTION

Space and Environment:

All VFD system components shall be housed in a grounded, dead front, free-standing or wall-mounting, NEMA 1 enclosure. The VFD system size shall not exceed the size allotments specified on the drawings nor shall any portion of the system exceed a height of 90 inches. Entry shall be provided for incoming line and load cables as required or as shown on the drawings.

VFD systems mounted indoors shall be properly ventilated and sized to operate continuously at the job site elevation in an ambient environment of 0°C. to 40°C, 0-90% RH. VFD systems mounted outdoors shall include environment control provisions as required (or as shown on the plans) to operate in an ambient of -30°C to 50°C, 0-100% RH.

Supply Power:

All components of the VFD system shall be selected to operate continuously without any system trip or damage based on the nominal power specifications and requirements shown on the drawings or schedules. The above conditions must be maintained under the following expected variations:

a. Plus or minus 10% voltage fluctuation.

b. Plus or minus 3% frequency variation (5% if served by a back-up generator).
c. Distorted voltage waveform with up to 7% total voltage harmonic distortion.

The VFD system shall employ voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions (based on preliminary IEEE working group P1346 data):

a. 0% voltage for 1 cycle.
b. 60% voltage for 10 cycles.
c. 87% voltage continuous.

VFD FEATURES

All inverters shall be manufactured in the United States.

The variable volume inverter duty motors and variable speed drives shall be manufactured by a single source. This will ensure total responsibility should a motor fail.

The inverter manufacturer shall have a minimum of 15 years experience in manufacturing inverters and shall have a minimum of 8 years experience with IGBT transistors used in the inverter to produce the output PWM waveform, allowing for quiet motor operation**.** Inverters with carrier frequencies below 8kHz are not acceptable.

The 3 through 30 HP, 230VAC, and 5 through 150 HP, 460VAC adjustable speed drive shall be a pulse width modulated (PWM) design that has a carrier frequency of 8kHz or higher so no acoustic noise will be produced onto the motor. The adjustable speed drive shall maintain a 120% current overload capability for 60 seconds with automatic stall prevention and voltage boost to prevent nuisance tripping during load or line side transient conditions. The adjustable speed drive shall maintain a displacement power factor of not less than 0.95 throughout its speed range.

The inverters shall be rated for continuous duty at a 8kHz carrier frequency on the motor full load currents listed below (from NEC Table 430-150). If derating of the inverter is necessary to run at 8kHz, then the units must be derated and their new derated currents must equal or exceed the motor full load currents listed in the table below.

The Insulated Gate Bipolar Transistors (IGBTs) shall have a minimum rating of 1200VDC on 460VAC and 600VDC on 230VAC units. The manufacturer of the inverter must have a minimum of 8 years experience in the manufacture and use of IGBTs.

Enclosure: The VFD shall have a metal NEMA 1 enclosure for reduction of radio and electromagnetic frequency interference. Plastic enclosures are not acceptable. The enclosure shall be wall mount 125HP and below and floor mount 200HP and above .

The adjustable speed drive shall have, as a minimum, the following design features as standard:

1. 8KHz sine-coded, pulse width modulated output.
2. Overload capability of 120% for 60 seconds, 110% continuous.
3. Process follower 4-20mADC, 0-5VDC, or 0-10VDC input.
4. An LED digital readout displaying output frequency, status, percent current, percent voltage, and response signal.

5. Output signals proportional to current and frequency 0-1mADC / 0-7.5VDC.
6. Current limiting circuit.
7. Adjustable acceleration and deceleration.
8. In addition to the inverter's self diagnostic features, the drive shall have a form C contact (1NO, 1NC) for remote indication of fault.
9. Customer interlock for remote starting and stopping.
10. On loss of speed reference signal, the drive shall operate at a preset minimum speed so that the inverter will not drive the fan at a speed capable of causing system problems.
11. The drive shall provide a 24VDC open collector output signal which will indicate when the drive is running, and when the drive is at speed.
12. The drive shall be capable of restarting into a rotating motor by sensing the frequency of the rotating motor and starting into the motor at that frequency.
13. The drive shall have a digital keypad for performing all parameter adjustments and programming which shall include the following features:

    a. Quick setup key to allow for simple setup and expeditious startup.
    b. Manual/Off/Auto keys for selection of control mode.
    c. Fault clear/reset key.
    d. Run and stop keys for starting and stopping in manual mode.
    e. Up and Down arrow keys for adjustment of motor speed and adjustment of programming parameters.
    f. Program key for entering program mode for adjustment of parameters.
    g. Read/write key for changing parameters in program mode.

14. The drive shall have PID (set point) control.
15. The inverter shall have a DC link reactor which will reduce harmonics at the input. If a DC link reactor is not provided, an AC input line reactor or isolation transformer shall be provided (20HP and larger, 460V).
16. The drive shall be equipped with critical frequency avoidance where it shall be capable of avoiding up to three resonant points in the mechanical system.
17. A user programmable personal lockout code shall prevent unauthorized programming of the inverter.

The adjustable speed drive shall have, as a minimum, the following protective features:

1. Ground fault protection.
2. Electronic motor overload protection.
3. Current limit adjustable 10 - 120%.
4. Current limited stall prevention during acceleration, deceleration, and run conditions.
5. Automatic restart after momentary power loss or momentary overvoltage. The drive shall not restart into faults other than overvoltage, undervoltage, or overcurrent due to acceleration rate set too fast, because other faults, such as an overcurrent due to a blown transistor or a short circuit on the output, could cause damage to the inverter.
6. Fault indicators shall indicate the following fault conditions (Faults should be displayed by flashing on the LED display on the front panel of the inverter. When a fault occurs, the drive shall have built in diagnostic functions that assist in determining the cause and source of the fault. The drive shall also indicate the level of current and voltage and the frequency at the time of the fault):

    a. Overcurrent during acceleration (OC1).

b. Overcurrent during deceleration (OC2).
c. Overcurrent while running (OC3).
d. Overcurrent on output (OCL).
e. Overcurrent detected at startup (OCA).
f. Overload (OL).
g. Overvoltage while deceleration (OP2).
h. Overvoltage due to power surge (OP).
i. Over temperature (OH).
j. Ground Fault (EF).
k. Emergency Stop (E).
l. Frequency Setting Fault (EFF).
m. EEPROM Abnormality (EEP).
n. EEPROM Abnormality (EEP2).
o. EEPROM Abnormality (EEP3).
p. Computer Link Abnormality (Err.t).
q. Power Supply Undervoltage (POFF).
r. DC Main Circuit Undervoltage (nOFF).

7. Current limiting DC bus fuse.
8. Phase-to-phase short circuit protection.

The adjustable speed drive shall have the following adjustments available under the quick SETUP key:

1. Acceleration - 0.1 to 1200 seconds.
2. Deceleration - 0.1 to 1200 seconds.
3. Maximum frequency range.
4. Maximum frequency (0 to 100% speed).
5. Bias and gain adjustment for 4-20mA, 0-5VDC, 0-10VDC follower (Can be direct or indirect acting).
6. Electronic thermal overload adjustment (10-100%).

The adjustable speed drive shall be designed to operate within the following environmental and service conditions:

1. Ambient service temperature: -10°C to 40°C.
2. Ambient storage temperature: -20°C to 60°C.
3. Humidity: non-condensing to 95%.
4. Altitude to 4400 feet.
5. Service factor: 1.1.
6. Input voltage: three phase, 208/230VAC -/+ 10% for 230VAC series and 380/400/460VAC +/- 10% for 460VAC series.
7. Input frequency: 50/60 hertz +/- 2 Hz.

The adjustable speed drive shall be designed and built to the following standards:

1. UL
2. CSA
3. ISO 9001
4. IEEE 587

Inverter manufacturer shall have the following available:

1. Service engineer.
2. Training/Service schools.
3. Twenty-four hour phone service.

Accessories to be furnished and mounted by the drive manufacturer:

Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, fault contact output, input reference signal, and external start command. All external interlocks shall remain fully functional whether the drive is in Hand or Auto modes. External start command shall be active when in the Auto mode only.

Run Relay - Provides 1 N.O. and 1 N.C. form C contact for indication of inverter running.

RS232 Computer Interface - Allows inverter to be controlled by a local computer terminal. Only one inverter may be controlled by each computer. All programming, monitoring, and control functions which are possible at the inverter may be performed through the computer terminal.

Floating Point Control - This option allows control of the inverter through three sets of external contacts. When Contact #1 closes, the inverter will ramp up in speed (accelerate). When Contact #1 opens, the inverter will stay at its current speed. When Contact #2 closes, the inverter will ramp down in speed (decelerate). When Contact #2 opens, the inverter will stay at its current speed. When Contact #3 closes, the inverter will stop.
Isolated Input Option - This option will optically isolate a 4-20mA input signal from the inverter. This can prevent ground loops from occurring which may interfere with the control signal.

Isolated 4-20mA Output Option - This option will provide a 4-20mA isolated output signal that is proportional to either frequency OR current. It converts the inverter's 0-1mA output signal into a 4-20mA signal.

QUALITY ASSURANCE

The VFD system manufacturer shall have a quality assurance program acceptable to the engineer. An outline of this program shall be submitted for approval as noted in 1.7.

Prior to shipping any equipment, the manufacturer shall individually test and certify each unit to document compliance. This certification report shall be submitted as part of the operation and maintenance manual and include the following minimum testing:

1. A visual inspection shall be made consisting of all system components, wiring connections, and safety mechanisms.
2. High pot testing shall be conducted on the completed VFD system including all accessory power components as a complete package. This test shall be conducted per UL 508 (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.
3. A system run test shall be conducted using an actual motor accelerated and decelerated through the entire speed range.

4. All control panel devices, including switches, pilot lamps, keypad and special control devices shall be functional tested.
5. Special tests shown on the drawings or schedules or as later required by the engineer to demonstrate compliance with any specification herein shall be conducted upon request (either witnessed or not) at no additional cost.

PART 3 - POWER QUALITY REQUIREMENTS

IEEE STD. 519-1992 COMPLIANCE

Compliance with IEEE STD. 519-1992 (Recommended Practices for Harmonic Control in Electrical Power Systems) shall be a requirement of this project. Harmonic filters (passive or active), phase multiplication devices, or any other components required to mitigate harmonic voltage and current to IEEE STD. 519-1992 published levels shall be an integral part of the VFD system. Designs which are not pre-integrated and factory wired as part of the UL (or equal) labeled VFD system shall not be acceptable under this specification.

1. Designs which employ shunt tuned filters must be designed to prevent the importation of outside harmonics which could cause system resonance or filter failure. Calculations supporting the design, including a system harmonic flow analysis, must be provided as part of shunt tuned filter design documentation.
2. Designs which cause voltage rise at the VFD terminals must document coordination with the total system voltage variation to eliminate nuisance tripping.
3. Designs which do not provide both true and displacement power factor (measured at the VFD system input terminals) of at least 95% or better at full load are not acceptable. Designs that allow leading power factor at minimum loads which create voltage rise on the line side of the VFD system are not acceptable (see 2.3 E.2).

Relevant data for VFD system vendor calculations to meet IEEE Std. 519-1992 requirements are as follows:

1. For the purpose of this specification, the Point of Common Coupling (PCC) as identified in IEEE Std. 519-1992, shall be the connection at which each individual VFD system (the offending non-linear load) is connected to the electrical distribution system (linear loads). Required voltage and current harmonic distortion measurements shall be taken at each individual VFD system PCC.
2. The load current (I_L) is used to calculate the IEEE Std. 519-1992 I_{SC}/I_L ratio required for determining acceptable maximum harmonic current distortion table values as reproduced in 3.1.B.4. For the purposes of this specification, this calculated current (I_L) shall be the total combined full load current of each VFD system supplied as part of this project or the total combined amperage of loads designated as "non-linear" on the drawings or schedules.
3. The VFD system vendor is responsible to determine the short circuit current (I_{SC}) available at the PCC through the drawings, through coordination with other equipment suppliers, from the electric utility, and/or from actual job site electrical equipment nameplate or measurement data.
4. As a convenience, the IEEE Std. 519-1992 table of current distortion limits for general distribution systems (120 V through 69,000 V) is given below:

Current Distortion Limits for General Distribution Systems
(120 V through 69,000 V)

Maximum Harmonic Current Distortion in percent of I_L

I_{SC}/I_L	<11	11£h<17	17£h<23	23£h<35	35£h	TDD
Individual Harmonic Order (Odd Harmonics)						
<20	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits above.

Documentation of IEEE Std. 519-1992 compliance shall be part of the commissioning required be the VFD supplier. Actual job site measurement testing shall be conducted at one half and full load and documented in the operation and maintenance manuals. Reports shall include the following data:

1. Data (text and graphical) shall be supplied showing voltage and current waveforms, THD (or TDD) and individual harmonic spectrum analysis in compliance with the above standards.
2. Power quality reports including transformer derate analysis, telephone influence factor, true and displacement power factor, and voltage and current imbalance reports shall also be supplied.

All VFD suppliers shall obtain pre-approval based on satisfactory completion of previous VFD projects meeting the above requirements. Pre-approval requests to bid shall include calculations, test reports and other sufficient data to show the owner/engineer how compliance to IEEE Std. 519-1992 requirements have been met on previous projects and how compliance will be accomplished on this project.

PART 4 - EXECUTION

INSTALLATION

Division 23 shall be responsible for mounting VFD.

The VFD system equipment shall be installed and tested under the direction of factory trained personnel as specified in 1.2B & 4.2. The installation shall be certified based on the approved form submitted as part of section 1.7.

SYSTEM COMMISSIONING AND CERTIFICATION

The VFD system start-up shall be performed by a service technician or engineer certified by the manufacturer. It shall include a minimum of 3 hours per VFD to work with Division 23 to start-up and

commission the VFD's during system and building start-up. The following adjustments and tests shall be performed as a minimum with certified copies included in the maintenance and operation manual:

1. Verify that the input voltage is within the manufacturer's specification tolerances.
2. Verify that the motor rotation is correct in all modes of operation.
3. Verify all operator devices, programming and monitoring functions to be fully operational.
4. Verify operation of all field signal control connections.
5. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.
6. Make all parameter adjustments to tune and optimize the VFD system to the application. Record all configuration values as part of this report.
7. Conduct harmonic tests as identified in 3.1C. Measurements shall be recorded for each unit with the VFD system off, running at 50% speed, and running at full speed and load.

Owner training shall be provided for each model and type of VFD system provided.

DOCUMENTATION

The VFD system vendor shall supply certified as-built drawings based on the required drawings and approved drawing formats included as part of the submittal process (see section 1.7).

1. The drawings shall be included as part of the operation and maintenance manual and be of a reproducible quality.
2. Autocad format files of each drawing shall also be included on a floppy disk.

The operation and maintenance manuals shall consist of the following instructions and information:

1. Uploading, handling, installation, and special consideration instructions.
2. Operating functional descriptions and operating instructions.
3. Bill of materials with all spare parts ordering information and availability.
4. Factory test reports per 2.5.
5. Start-up and system commissioning reports per 4.2A.
6. Training certification per 4.2B.
7. Power quality and harmonic test reports per 3.1C.

WARRANTY

The VFD system vendor shall supply a complete parts and labor warranty (including travel expenses) for 1 year from the date of substantial completion.

1. The warranty shall cover the entire VFD system including power devices, controllers, filters, etc. enclosed as part of the system package.

END OF SECTION

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.
7. Engineer approved equal.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

E. VFC Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. AFC Cable Systems, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.
10. Engineer approved equal.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. VFC Output Circuits: Type XHHW-2 in metal conduit with braided shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

END OF SECTION 26 0519

SECTION 26 0523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Low-voltage control cabling.
2. Control-circuit conductors.
3. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

E. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches (1520 mm) or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 CONTROL-CIRCUIT CONDUCTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Encore Wire Corporation.
2. General Cable Technologies Corporation.
3. Southwire Company.
4. Engineer approved equal.

B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
2. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches (75 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
2. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
3. Cables may not be spliced.
4. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Do not use heat lamps for heating.
7. Support: Do not allow cables to lay on removable ceiling tiles.
8. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

3.3 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GROUNDING

A. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION 26 0523

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for periodic testing and inspection of grounding features at test wells and grounding connections for separately derived systems based on NFPA 70B.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A Brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.
11. Engineer approved equal.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m).

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Metal-clad cable runs.

B. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

C. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Section 260548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.
h. Engineer approved equal.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
      5) Engineer approved equal.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.
      6) Engineer approved equal.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: [Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.

7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and other painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 0529

SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney.
6. Picoma Industries.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company.
13. Engineer approved equal.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel or aluminum.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.

b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corporation.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions; Carlon Electrical Products.
10. Niedax-Kleinhuis USA, Inc.
11. RACO; Hubbell.
12. Thomas & Betts Corporation.
13. Engineer approved equal.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.
5. Engineer approved equal.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. Mono-Systems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.
d. Engineer approved equal.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman.
7. Hubbell Incorporated.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney.
12. RACO; Hubbell.
13. Robroy Industries.

14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.
18. Engineer approved equal.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

K. Gangable boxes are allowed.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. NewBasis.
   d. Oldcastle Precast, Inc.
   e. Quazite: Hubbell Power System, Inc.
   f. Synertech Moulded Products.
   g. Engineer approved equal.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: IMC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm)of enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m)intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from RNC, Type EPC-40-PVC, to GRC or IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated

throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm)radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

U. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and

complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION 26 0533

SECTION 26 0543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Direct-buried conduit, ducts, and duct accessories.
2. Handholes and boxes.

1.3 DEFINITIONS

A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including separators and miscellaneous components.
2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for manholes, handholes, boxes.
4. Include warning tape.

B. Shop Drawings:

1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.

1.5 FIELD CONDITIONS

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

1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect's written permission.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

A. Comply with ANSI C2.

2.2 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or a comparable product by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corporation.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Spiraduct/AFC Cable Systems, Inc.
11. Engineer approved equal.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Christy Concrete Products.
2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast Group.
4. Rinker Group, Ltd.
5. Riverton Concrete Products.
6. Utility Concrete Products, LLC.

7. Utility Vault Co.
8. Wausau Tile Inc.
9. Engineer approved equal.

B. Comply with ASTM C 858 for design and manufacturing processes.

2.5 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

1. Color: Gray or Green.
2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. NewBasis.
d. Quazite: Hubbell Power System, Inc.
e. Engineer approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.4 DUCT INSTALLATION

A. Install ducts according to NEMA TCB 2.

B. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.

D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in empty ducts.

H. Direct-Buried Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.
2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
3. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade unless otherwise indicated.
4. Set elevation of bottom of duct bank below frost line.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

I. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF HANDHOLES AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below frost line.
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

END OF SECTION 26 0543

SECTION 26 0548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Spring isolators.
3. Restrained spring isolators.
4. Channel support systems.
5. Restraint cables.
6. Hanger rod stiffeners.
7. Anchorage bushings and washers.

B. Related Sections include the following:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: F.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.

a. Component Importance Factor: 1.25.
b. Component Response Modification Factor: 1.5.
c. Component Amplification Factor: 1.0.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): .

4. Design Spectral Response Acceleration at 1.0-Second Period: .

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by agency acceptable to authorities having jurisdiction.
   b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

   a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:

   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.
10. Engineer approved equal.

C. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.
9. Engineer approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 0548

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Colors for Cables Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.5 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 100 A, and 208 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.

3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

E. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive vinyl labels with the conductor designation.

F. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.

K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Adhesive film label, Self-adhesive, engraved, laminated acrylic or melamine label, or Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Switchgear.
e. Switchboards.
f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
g. Emergency system boxes and enclosures.
h. Motor-control centers.
i. Enclosed switches.
j. Enclosed circuit breakers.
k. Enclosed controllers.
l. Variable-speed controllers.
m. Push-button stations.
n. Contactors.
o. Remote-controlled switches, dimmer modules, and control devices.

END OF SECTION 26 0553

SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Time switches.
2. Indoor occupancy sensors.
3. Lighting contactors.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Cooper Industries, Inc.

2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Mfg. Company Inc.
5. NSi Industries LLC; TORK Products.
6. Tyco Electronics; ALR Brand.
7. Engineer approved equal.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: SPST.
3. Contact Rating: 30-A inductive or resistive, 240-V ac.
4. Programs: sixteen channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
5. Astronomic Time: All channels.
6. Automatic daylight savings time changeover.
7. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

C. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: SPST.
3. Contact Rating: 30-A inductive or resistive, 240-V ac.
4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
5. Astronomic time dial.
6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
7. Skip-a-day mode.
8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 INDOOR OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.

12. Watt Stopper.
13. Engineer approved equal.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:

   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.
12. Watt Stopper.
13. Engineer approved equal.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

2.4 LIGHTING CONTACTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation.
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
5. Square D; a brand of Schneider Electric.
6. Engineer approved equal.

B. Description: Electrically operated and electrically held, combination-type lighting contactors, complying with NEMA ICS 2 and UL 508.

1. Enclosure: Comply with NEMA 250.
2. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

A. Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 0923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. ACME Electric Corporation; Power Distribution Products Division.
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Controlled Power Company.
4. Eaton Electrical Inc.; Cutler-Hammer Products.
5. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
6. General Electric Company.
7. Hammond Co.; Matra Electric, Inc.
8. Magnetek Power Electronics Group.

9. Micron Industries Corp.
10. Myers Power Products, Inc.
11. Siemens Energy & Automation, Inc.
12. Sola/Hevi-Duty.
13. Square D; Schneider Electric.
14. Engineer approved equal.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

H. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

I. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 26 2413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Accessory components and features.
5. Identification.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.

6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Architect's written permission.
4. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Engineer approved equal.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.
4. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V.

D. Main-Bus Continuous: 1600 A.

E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

F. Outdoor Enclosures: Type 3R.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for padlocking.

G. Barriers: Between adjacent switchboard sections.

H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

I. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

M. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

N. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with copper feeder circuit-breaker line connections.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

P. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Engineer approved equal.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. Six-digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277-V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277.
2. Line to Ground: 800 V for 480Y/277.
3. Neutral to Ground: 800 V for 480Y/277.

F. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:

1. Line to Line: 2000 V for 480 V.
2. Line to Ground: 1500 V for 480 V.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
   f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
   g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.5 IDENTIFICATION

A. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

B. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with

requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 2413

SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Keys: Two spares for each type of panelboard cabinet lock.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without written permission.
3. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Engineer approved equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

F. Install filler plates in unused spaces.

G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 2416

SECTION 26 2419 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes MCCs for use with ac circuits rated 600 V and less and having the following factory-installed components:

1. Incoming main lugs and OCPDs.
2. Full-voltage magnetic controllers.
3. Auxiliary devices.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. GFCI: Ground fault circuit interrupting.

F. IGBT: Insulated-gate bipolar transistor.

G. LAN: Local area network.

H. LED: Light-emitting diode.

I. MCC: Motor-control center.

J. MCCB: Molded-case circuit breaker.

K. MCP: Motor-circuit protector.

L. NC: Normally closed.

M. NO: Normally open.

N. OCPD: Overcurrent protective device.

O. PCC: Point of common coupling.

P. PID: Control action, proportional plus integral plus derivative.

Q. PT: Potential transformer.

R. PWM: Pulse-width modulated.

S. RFI: Radio-frequency interference.

T. SCR: Silicon-controlled rectifier.

U. TDD: Total demand (harmonic current) distortion.

V. THD(V): Total harmonic voltage demand.

W. TVSS: Transient voltage surge suppressor.

X. VFC: Variable-frequency controller.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of controller and each type of MCC. Include shipping and operating weights, features, performance, electrical ratings, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each MCC, manufacturer's approval, custom and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.

f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
g. Specified optional features and accessories.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends.
4. Vertical and horizontal bus capacities.
5. Features, characteristics, ratings, and factory settings of each installed unit.

1.6 INFORMATIONAL SUBMITTALS

A. Standard Drawings: For each MCC, as defined in UL 845.

B. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

C. Seismic Qualification Certificates: For MCCs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.

2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.

1.8 MAINTENANCE MATERIAL SUBMITTALS

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

1. Power Fuses: Equal to 10> percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.9 QUALITY ASSURANCE

A. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:

1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: Exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.

B. Interruption of Existing Electrical Service or Distribution Systems: Do not interrupt electrical service to, or distribution systems within, a facility occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical service without Architect's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs, including clearances between MCCs and adjacent surfaces and other items.

1.12 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate features of MCCs, installed units, and accessory devices with remote pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each MCC, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.

1.13 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. ABB; Control Products.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Industrial Systems.
4. Rockwell Automation, Inc.; Allen-Bradley Brand.
5. Siemens Energy & Automation, Inc.; Power Distribution.
6. Square D; a brand of Schneider Electric.
7. Engineer approved equal.

B. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845.

2.2 FUNCTIONAL FEATURES

A. Description: Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of MCC.

B. Controller Units: Combination controller units.

1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
2. Equip units in Type B and Type C MCCs with pull-apart terminal strips for external control connections.

C. Feeder-Tap Units: Through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.

D. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

E. Spare Units: Installed in compartments indicated "spare."

2.3 INCOMING MAINS

A. Incoming Mains Location: Top.

B. Main Lugs Only: Conductor connectors suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.

2.4 COMBINATION CONTROLLERS

A. Full-Voltage Controllers:

1. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.

2. Magnetic Controllers: Full voltage, across the line, electrically held.

a. Configuration: Nonreversing.

B. Disconnecting Means and OCPDs:

1. MCCB Disconnecting Means:

a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

C. Overload Relays:

1. Bimetallic Overload Relays:

a. Inverse-time-current characteristic.
b. Class 10 tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.

D. Control Power:

1. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 50 VA.

2.5 FEEDER-TAP UNITS

A. MCCB: Comply with UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2.6 MCC CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from CPT.

B. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 unless otherwise indicated to comply with environmental conditions at installed location.

B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

C. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.

D. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

E. Wiring Spaces:

1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

2.8 AUXILIARY DEVICES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

a. Push Buttons: Covered types; momentary contact unless otherwise indicated.
b. Pilot Lights: LED types; push to test.
c. Selector Switches: Rotary type.

B. Reversible NC/NO contactor auxiliary contact(s).

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

D. Spare control-wiring terminal blocks; wired.

2.9 CHARACTERISTICS AND RATINGS

A. Wiring: NEMA ICS 18, Class I.

B. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

C. Nominal System Voltage: 480 V, three phase, three wire.

D. Short-Circuit Current Rating for Each Unit: Combination series rated, 22kA.

E. Environmental Ratings:

1. Ambient Temperature Rating: Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C), with an average value not exceeding 95 deg F (35 deg C) over a 24-hour period.
2. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
3. Humidity Rating: Less than 95 percent (noncondensing).
4. Altitude Rating: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.

F. Main-Bus Continuous Rating: 600 A.

G. Vertical-Bus Minimum Continuous Rating: 300 A.

H. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating.

I. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends.

J. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.

K. Phase-Bus Material: Hard-drawn copper of 98 percent conductivity, tin plated.

L. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit equipment grounding conductors.

M. Front-Connected, Front-Accessible MCCs:
1. Controller Units: fixed mounted.

2. Feeder-Tap Units: fixed mounted.
3. Sections front and rear aligned.

N. Bus Transition and Incoming Pull Sections: Matched and aligned with basic MCC.

O. Pull Box on Top of an MCC:

1. Adequate ventilation to maintain temperature in pull box within same limits as MCC.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers forming top, front, and sides. Top covers at rear easily removable for drilling and cutting.
4. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
5. Cable supports arranged to facilitate cabling and adequate to support cables, including those for future installation.
6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

P. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of unit.

Q. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.10 SOURCE QUALITY CONTROL

A. MCC Testing: Inspect and test MCCs according to requirements in NEMA ICS 18.

B. MCCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of MCCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Floor-Mounting Controllers: Install MCCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label MCC and each cubicle with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.
4. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
10. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

E. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

3.9 PROTECTION

A. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 26 2419

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches.
4. Floor service outlets and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).
5. Engineer approved equal.

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5351 (single), CR5362 (duplex).
b. Hubbell; HBL5351 (single), HBL5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5361 (single), 5362 (duplex).
e. Engineer approved equal.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; VGF20.
b. Hubbell; GFR5352L.
c. Pass & Seymour; 2095.
d. Leviton; 7590.
e. Engineer approved equal.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

1) Single Pole:

2) Cooper; AH1221.
3) Hubbell; HBL1221.
4) Leviton; 1221-2.
5) Pass & Seymour; CSB20AC1.
6) Engineer approved equal.

7) Two Pole:

8) Cooper; AH1222.
9) Hubbell; HBL1222.
10) Leviton; 1222-2.
11) Pass & Seymour; CSB20AC2.
12) Engineer approved equal.

13) Three Way:

14) Cooper; AH1223.
15) Hubbell; HBL1223.
16) Leviton; 1223-2.
17) Pass & Seymour; CSB20AC3.
18) Engineer approved equal.

19) Four Way:

20) Cooper; AH1224.
21) Hubbell; HBL1224.
22) Leviton; 1224-2.
23) Pass & Seymour; CSB20AC4.
24) Engineer approved equal.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; AH1221PL for 120 and 277 V.
b. Hubbell; HBL1201PL for 120 and 277 V.
c. Leviton; 1221-LH1.
d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
e. Engineer approved equal.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.7 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.8 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.

2. Wiremold/Legrand.
3. Engineer approved equal.

B. Description:

1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: 12 inches (300 mm).
3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

2.9 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION 26 2726

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits and enclosed switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.7 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

5. Engineer approved equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
1. Motor Branch Circuits: Class RK1 time delay.
2. Control Circuits: Class CC, fast acting/time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 2813

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.8 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.9 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Engineer approved equal.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Engineer approved equal.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 2816

SECTION 26 2913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.

B. Related Section:

1. Section 262923 "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Nameplate legends.
d. Short-circuit current rating of integrated unit.
e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.
4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Rockwell Automation, Inc.; Allen-Bradley brand.
      d. Siemens Energy & Automation, Inc.
      e. Square D; a brand of Schneider Electric.
      f. Engineer approved equal.

   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
   4. Surface mounting.
   5. Green pilot light.

C. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Rockwell Automation, Inc.; Allen-Bradley brand.
      d. Siemens Energy & Automation, Inc.
      e. Square D; a brand of Schneider Electric.
      f. Engineer approved equal.

   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
   4. Surface mounting.
   5. Green pilot light.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

END OF SECTION 26 2913

SECTION 26 4113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes lightning protection for structures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

C. Field quality-control reports.

D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.
2. LPI System Certificate.
3. UL Master Label Recertification.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. East Coast Lightning Equipment Inc.
b. ERICO International Corporation.
c. Harger.
d. Heary Bros. Lightning Protection Co. Inc.
e. Independent Protection Co.
f. Preferred Lightning Protection.
g. Robbins Lightning, Inc.
h. Thompson Lightning Protection, Inc.
i. VFC, Inc.
j. Engineer approved equal.

2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.

C. Main and Bonding Conductors: Aluminum.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel, 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches (600 mm) from building foundation.
2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 26 4113

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Energy-efficiency data.
5. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."
6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
7. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Installation instructions.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.9 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

I. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

2.2 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: 0.98 or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.

D. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

E. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

F. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

2.3 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.98 or higher.

2.4 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1400 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
3. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
2. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
3. Lamp end-of-life detection and shutdown circuit.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Lamp Current Crest Factor: 1.5 or less.
8. Power Factor: 0.90 or higher.
9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
10. Protection: Class P thermal cutout.
11. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

2.6 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.

c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.7 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

2.8 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

C. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

D. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.9 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and color temperature 4000 K.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000> K.

2.10 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 26 5100

SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related Sections:

1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure, including tower used for large area illumination.

G. Standard: Same definition as "Pole" above.

1.4 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.

3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected from manufacturer's standard catalog of colors.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I,

integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: Dark bronze.

O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

a. "USES ONLY" and include specific lamp type.
b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

2.3 FLUORESCENT BALLASTS AND LAMPS

A. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F (minus 29 deg C) and higher.

2.4 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

2.5 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000 K.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

2.7 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Square, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with galvanized-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

G. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

H. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

I. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind

welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

E. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

END OF SECTION 26 5600

AUDIO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install complete and operational sound systems as described in Contract Documents to include all equipment and materials, whether specifically mentioned herein or not, to ensure complete and operational systems.
   2. Assist Audio / Video Consultant with commissioning and equalization of system and provide necessary test equipment for sound system tests. Correct problems found at time of commissioning of system.

B. Related Requirements:
   1. Division 26:
      a. Raceways, boxes, and fittings.
   2. Audio / Video Consultant will perform commissioning, system balance, and equalization.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate commissioning schedule with Audio / Video Consultant three weeks minimum before Consultant's commissioning.

1.3 SUBMITTALS

A. Informational Submittals:
   1. Itemized list of equipment to be supplied with product data sheets in order shown on drawings
   2. Shop drawings
   3. System programming

B. Closeout Submittals:
   1. Include following in Operations And Maintenance Manual:
      a. Operations and Maintenance Data:
         1) Equipment Manufacture’s manual
         2) Sound system operation and maintenance instructions.
         3) List of equipment provided, including portable equipment, showing make, model, and serial number.
      b. Warranty Documentation:
         1) Include copy of final, executed warranties.
      c. Record Documentation:
         1) As-built drawings
         2) Software and Programming: Copies of all manufacturers’ software used for programming various components and functions of the system shall be furnished to the Owner:
            a) Original source codes and compiled codes used for system control, audio setup and any other computerized functions of the system including screen layout generation, configuration and layouts and any other related computer files shall also be furnished to the Owner.
            b) In each and every case, all programming, code generation, configuration files, layout files and any other software and/or code written and generated of the setup and operation of this system are the property of the Owner of the system and not of the consultant, contractor or integrator.

1.4 QUALITY ASSURANCE

A. Qualifications: Requirements is not limited to following:
   1. Installers Qualifications:
      a. Approved Installers. Specified installers are to both furnish and install components of sound system.
         1) Avidex: (801) 973-6483
         2) Cache Valley Electric: (801) 908-2670
         3) General Communications: (801) 266-5731
         4) Marshall Industries: (801) 266-2428.
         5) Poll Sound: (801) 261-2500.
         6) Professional Systems Technology, Inc. (801)649-6696
         7) TPI: (801)702-8242
         8) Bids submitted by non-pre-qualified bidders will not be accepted.
      b. Installer's Qualifications:
         1) The work of this section will be contracted to a single firm, referred to as the Sound Installer for undivided responsibility.
         2) The Sound Installer must be experienced in the installation of professional sound systems and have completed within the past five years at least five sound system projects of a size and scope comparable to the project described herein.
         3) The Sound Installer shall have capabilities and in-house facilities for installation, shop fabrication and repair service of professional sound systems.
         4) The Sound Installer shall have on his full-time payroll at least one staff engineer having five years minimum experience as an Audio engineer. In place of a qualified staff engineer, the Sound Installer may retain a consulting engineer to direct the project. Prior to bid acceptance, the qualifications of the consulting engineer shall be submitted for the approval of the Audio / Video Consultant. Said staff or consulting engineer shall:
            a) Provide all technical liaisons between the Sound Installer and the Consultant.
            b) Represent the Sound Installer at meetings and conferences, and be present at the job site for final inspection/
            c) Be responsible for supervision of all technical and engineering work required executing the contract, and in particular, approving and signing of all shop drawings.
         5) Must be a dealer or distributor of equipment included in bid and provide documents from manufacturers stating such.
         6) Outline the general scope of past project, normal staffing levels, and union status of shop and field installation personnel.
         7) List a minimum of three (5) projects of similar scope successfully completed, indicating the location, type of system installed, total contract amount, date completed, and include persons and telephone number to contact.
         8) Submit the above, as well as confirmation of current state or local contracting licenses, five days prior to bid date, as required to perform the work under this section.
   2. Manufacturer's Qualifications:
      a. Firms regularly engaged in manufacture of sound system components and accessories for more than 5 years.

1.5 WARRANTY

A. Special Warranty:
   1. Provide complete warranty repair or replacement for one year from commissioning at no cost to Owner, except in case of obvious abuse.
   2. Honor component warranties for term established by Manufacturer if greater than one year.
   3. Activate all manufacturers' equipment warranties in Owner's name to commence on the date of acceptance.
   4. Replace defective equipment and faulty workmanship within 72 hours of discovery at no cost to the Owner during the warranty.
   5. If, during the warranty period, any component is out of service for more than one week due to unavailability of parts or service, supply and install an identical new component. If an identical component is not available, substitute equivalent equipment, but only with approval of the Owner.

PART 2 - PRODUCTS

2.1 SYSTEM

A. Performance:
   1. Capabilities:
      a. Installations with equalizers shall meet following performance parameters:
         1) From 100 Hz to 2 kHz, flat within plus or minus 2 dB.
         2) Above 2 kHz, slope down along an approximate 3 dB per octave slope to 8 kHz.
      b. No noise, hum, RFI pickup or distortion shall be audible under normal operating conditions.
      c. Sound systems shall reproduce program material at level of 80 to 85 dBA without audible distortion.
      d. All input levels shall be pre-set so system may be operated without going into feedback under normal conditions.
      e. Seat-to-seat variations in the 2kHz octave band shall not exceed plus or minus 2 dB.

PART 3 - EXECUTION

3.1 FIELD COOPERATION

A. Cooperate at all times and to the fullest extent with all trades during work to the end that lost time, work stoppages, interference, and inefficiencies do not occur.

3.2 SHOP DRAWINGS SUBMITTALS

A. Submit shop drawings of systems prior to fabrication:
   1. System functional block drawings including all equipment names and model numbers.
   2. Provide full scale drawings of all custom plates and panels indicating exact lettering, critical dimensions, and finish.
   3. Provide a list of test equipment, including manufacturer, description and model number of the test equipment expected to be employed in the test and adjustment of the systems.

3.3 EXAMINATION

A. Verification Of Conditions:
   1. Verify compliance with following items before beginning work of this Section.
      a. No cables spliced.
      b. Isolated grounds run back to electrical panel from all equipment cabinets.
      c. Specified conduit, cables, speaker enclosures and equipment cabinets are properly installed.

3.4 INSTALLATION

A. Equipment
   1. Provide new equipment that shall meet or exceed the latest published specifications of the manufacturer in all respects as specified in the Equipment List on the drawings.
   2. Supply the latest model, available at the time of bidding, of each piece of equipment.
   3. Color of devices shall be reviewed and approved by the architect.

B. Speakers:
   1. Maintain uniform polarity in speakers and wiring.
   2. Employ no positive stop in rotation of speaker volume controls. Controls shall be capable of continuous rotations in either direction.

3. Neatly mount speaker grilles, panels, connector plates, control panels, etc., tight, plumb, and square unless indicated otherwise on drawings.
4. Aim speakers as shown on the drawings.
5. Provide adequate fastenings and supports with a safety load factor of at least three and adhere to all seismic requirements.

C. Equipment Cabinet:
1. Install vent panels at top and bottom of equipment cabinets for maximum ventilation. Locate amplifiers at top of cabinet if convection cooled or at the bottom if amplifier contains fans. Locate digital signal processors in the middle of equipment cabinet, separated by several blank panels.
2. Securely fasten equipment plumb and square in place. Utilize all fastening holes in front of cabinet.
3. Securely fasten in place equipment that is not rack mounted, including relays and other small components. Do not use sticky-back tape.
4. Install balancing / isolation transformer when balanced and unbalanced components are connected.
5. Wire XLR-type connections with pin 2 hot, pin 1 shield.
6. Connect powered components to 120 VAC outlets on voltage suppressors or power bars. Do not connect to outlets on other components.
7. Identification:
   a. Legibly identify user-operated system controls and system input / output jacks using engraved, permanently attached laminated plastic plates or imprinted Lexan labels. Label equipment and controls within equipment cabinets using similar labels or printed labels from a label maker or laser printer.
   b. Affix label to rack panel inside cabinet listing name and telephone number of installer. Appropriate warranty instructions may be included.

D. Cables:
1. Leave sufficient service loops of uniform length on cables to allow for future equipment replacement.
2. Make parallel connections or splices on standard barrier terminal blocks, or on equipment terminals using appropriate connection type. Do not attach more than three wires under any one screw terminal.
3. Strip and heat shrink tubing on wires installed in Euroblock or Phoenix connectors so 1/16 inch (2 mm) of wire is exposed outside connector when wire contacts back of connector:
   a. Secure wires using screwdriver with blade of same width as screw slot and handle 3/4 inch (19 mm) minimum diameter and of length to allow applying sufficient torque to prevent wires from becoming disconnected.
4. Terminate conductors with proper mating connectors:
   a. Do not use adapters.
   b. Use proper crimp tool as recommended by Connector Manufacturer.
5. Male CAT-6 connectors shall be grey-smoked or blue-smoked RJ-45's.
   a. After installing RJ-45 connectors, test CAT-6 cables for shorts, opens, and cross-pairing with two-piece wire-mapping continuity tester.
6. Secure cables to equipment cabinet with wire ties to ensure neat installation:
7. Ground both ends of each cable shielded within equipment cabinet only. Ground microphone cables only at mixer.
8. Label within 6” of both ends of cables with source and destination. Use Hellermann Tyton Tag 49L-105 or similar label types.
   a. Example 1: PULPIT MIC: MIXER IN 1.
   b. Example 2: DSP OUT B: CC1 AMP IN.
   c. Group all cables according to the signals being carried. In order to reduce signal contamination, form separate groups for the following cables:
      1) Microphone cables
      2) UTP, sound system control, telephone, video or ATC cables
      3) Loudspeaker cables
      4) Antenna cables
      5) Power cables at least a foot away from the above.
9. Install no cable with a bend radius less than that recommended by the cable manufacturer.

10. Grommets and other devices shall be used to insure the integrity of the cable now and in the future.
11. Bundle multiple cables in Tech Flex if in full view of the owner.
12. Use plenum rated cable, tie-wraps, and supports when conditions require it.
13. Free wire cable shall be supported every 4 feet and not lay on top of ceiling or other objects in the plenum space.

E. Equipment installed in millwork shall be cut in with the upmost care and aesthetic value. Verify that adequate cooling for the electronics is sufficient.

F. During installation if surfaces become damaged intentionally or unintentionally they shall be repaired in a professional manner at no cost to the owner.

3.5 FIELD QUALITY CONTROL

A. Field Tests:
1. Installer Testing:
   a. After completion of installation but before commissioning by Audio / Video Consultant, perform following:
      1) Conduct system tests and make necessary corrections for proper system operation including, but not limited to, following:
         a) Output level uniformity.
         b) Polarity.
         c) Shock, strain excited hum, and oscillation.
         d) Clipping, hum, noise, and RFI in all system configurations.
         e) Speaker line impedances.
         f) Loose parts and poor workmanship.
      2) Sweep speaker systems with high-level sine wave noise source. Correct causes of buzzes or rattles related to speakers or enclosures. Notify Contractor and Audio / Video Consultant of external causes of buzzes or rattles.
      3) Aim speakers as shown on drawings and verify coverage.
      4) Rough Balance: Balance system well enough that it can be used before commissioning.
   b. Complete documentation and submit to consultant 5 days prior to Substantial Completion.
      1) Written notification with settings and as-built drawings.
      2) Electronic copy of Operation and Maintenance Manual.

B. Field commissioning:
1. Audio / Video Consultant commissioning:
   a. Coordinate commissioning schedule with Audio / Video Consultant three weeks minimum before Consultant's visit.
   b. Have copy of redlined record documents available 5 days prior to Substantial Completion.
   c. Have loose equipment (microphones, cables, etc.) available at time of commissioning.
   d. Assist Audio / Video Consultant in the commissioning of completed systems.
   e. Provide following test equipment in good working order:
      1) Laptop computer, 100 MHz Pentium or better, with 16 bit sound card, software, and interfacing adapters for microprocessor controlled equipment in system.
      2) 1/12 octave real-time audio spectrum analyzer with SPL meter, and precision microphone.
      3) Digitally generated random pink noise generator, 20Hz-20KHz, minimum 2 hour repetition rate or 10 minutes minimum of equivalent signal.
      4) Direct reading audio impedance meter, minimum 3 frequencies, and 10 percent accuracy.
      5) Digital Volt-Ohmmeter.
      6) Audio oscillator, variable frequency, 20 Hz to 20 KHz.
      7) MP3 player, with pre-recorded speech and music program material.
      8) Necessary chargers, cables, test leads, adapters, and other accessories for test equipment.

9) Tools and spare parts for making adjustments and corrections to system.
10) CAT-6 / RJ-45 continuity tester similar to Ideal 62-200 or Amprobe DCT-300.

f. Correct minor items so Audio / Video Consultant may certify satisfactory completion during his visit.

C. Training
1. Provide training in the operation and maintenance of the systems by a qualified instructor or equipment manufacture for personnel designated by the Owner.
2. Training shall be after the systems are operational but before the commissioning.
3. Provide two DVD recordings of the training to the owner.

3.6 SYSTEM ACCEPTANCE

A. System acceptance tests shall not be performed until the initial system checkout has been completed. The system acceptance tests shall be supervised by the Consultant and shall consist of the following:
1. Take a physical inventory of all equipment on site and compare to equipment lists in the contract documents.
2. Demonstrate the operation of all system equipment.
3. Both subjective and objective tests will be required by the Consultant to determine compliance with the specifications. Provide test equipment specified by the Consultant for these tests.
4. Provide all final, "as-built" drawings, manuals, instruction video (DVD format) and other required documents.

B. In the event that the systems are not completely installed or further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Consultant. The Consultant's return trip shall be paid for by the installer prior to the Consultants return.
1. If the need for further adjustments becomes evident during the demonstration and testing, continue work until the installation operates properly. Included in the continued work shall include, but not be limited to, readjustment of loudspeaker aiming, adjustment of system equalizers, programming changes to the control system, if in the judgment of the Consultant, these adjustments are required.
2. If acceptance of the system is delayed because of defective equipment or because the equipment does not fulfill this specification, reimburse the Consultant for all time and expenses of the Consultant for these tests during any extensions of the acceptance-testing period.

3.7 CLEANUP AND REPAIR

A. Upon completion of the work, remove all refuse and rubbish from and about the premises daily, and shall leave the relevant areas and equipment clean and in an operational state. Repair any damage caused to the premises by the installation activities, at no cost to the Owner.

3.8 PROTECTION OF WORK

A. During the installation, and up to the date of final acceptance, protect finished and unfinished work against damage and loss. In the event of such damage or loss, replace or repair such work at no cost to the Owner.

END OF SECTION

SECTION 31 1000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees and vegetation to remain.
2. Removing trees and other vegetation.
3. Clearing and grubbing.
4. Topsoil stripping.
5. Removing above-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place.
7. Disconnecting, capping or sealing, and removing site utilities.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of weeds, roots, and other deleterious materials.

1.4 MATERIALS OWNERSHIP

A. Except for materials indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings according to Division 1 Section "Contract Closeout."

1. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Notify utility locator service for area where Project is located before site clearing.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 33 Section "Earthwork."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.
2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
3. Coat cut faces of roots more than 1-1/2 inches (38 mm) in diameter with emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

1. Employ a qualified arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist. Tree replacement shall be a quantity of two for one of the type, ratio and location on campus as directed by the campus arborist.

3.3 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify University not less than three days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without University’s written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
4. Use only hand methods for grubbing within drip line of remaining trees.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding 8-inch (200-mm) loose depth, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches (1800 mm) unless permitted otherwise by the owner.
2. Do not stockpile topsoil within drip line of remaining trees.
3. Dispose of excess topsoil as specified for waste material disposal.
4. Stockpile surplus topsoil and allow for respreading deeper topsoil.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 1000

SECTION 31 5000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:

1. Section 01 3200 "Construction Progress Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 01 5000 "Temporary Facilities and Controls" for temporary utilities and support facilities.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Monitor vibrations, settlements, and movements.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For excavation support and protection system.

B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified land surveyor.

B. Other Informational Submittals:

1. Photographs: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

   a. Note locations and capping depth of wells and well points.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

   a. Geotechnical report.
   b. Existing utilities and subsurface conditions.
   c. Proposed excavations.
   d. Proposed equipment.
   e. Monitoring of excavation support and protection system.
   f. Working area location and stability.
   g. Coordination with waterproofing.
   h. Abandonment or removal of excavation support and protection system.

1.7 PROJECT CONDITIONS

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

1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
2. The geotechnical report is included by reference elsewhere in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock or roll-formed corner shape with continuous interlock.

C. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

E. Tiebacks: Steel bars, ASTM A 722/A 722M.

F. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Section 31 2000 "Earth Moving."
3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 5000

SECTION 321216

HOT-MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt patching.
2. Pavement-marking paint.

1.3 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the standard specifications of the state or of authorities having jurisdiction.

1.4 SUBMITTALS

A. Product Data: For each product specified. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate dedicated handicapped spaces with international graphics symbol.

D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work on public property.

C. Asphalt-Paving Publication: Comply with AI's "The Asphalt Handbook," except where more stringent requirements are indicated.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings" Review methods and procedures related to asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
2. Review condition of substrate and preparatory work performed by other trades.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute the Work without delays.
5. Review inspection and testing requirements, governing regulations, and proposed installation procedures.
6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location and within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:

1. Tack Coats: Minimum surface temperature of 60 deg F (15.5 deg C).
2. Asphalt Base Course: Minimum surface temperature of 40 deg F (4 deg C) and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.5 deg C) at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4 deg C) for oil-based materials, 50 deg F (10 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: Sound; angular crushed stone; crushed gravel; or properly cured, crushed blast-furnace slag; complying with ASTM D 692.

C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone; gravel, properly cured blast-furnace slag, or combinations thereof; complying with ASTM D 1073.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D 242.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: ASTM D 3381 for viscosity-graded material.

B. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

A. Sand: ASTM D 1073, Grade Nos. 2 or 3.Retain above or below or delete both if no pavement marking is required. Drying time of paint types above is 30 minutes. Faster drying paint, FS TT-P-115, Type II, or AASHTO M-248, Type F, may be available. Verify with manufacturers. Water-base emulsion below takes 2 hours to dry.

B. Pavement-Marking Paint: Latex, water-base emulsion, ready-mixed, complying with FS TT-P-1952.

1. Color: Yellow or white to match existing.

C. Glass Beads: AASHTO M 247, Type 1

2.4 MIXES

A. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI's "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Provide mixes complying with the composition, grading, and tolerance requirements of ASTM D 3515 for the following nominal, maximum aggregate sizes:

   a. Base Course: 1 inch.
   b. Surface Course: 1/2 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify Architect in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.2 PATCHING AND REPAIRS

A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

   1. Tack coat faces of excavation and allow to cure before paving.
   2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
   3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

B. Tack Coat: Apply uniformly to existing surfaces of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m) of surface.

   1. Allow tack coat to cure undisturbed before paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.

1. Place hot-mix asphalt surface course in single lift.
2. Spread mix at minimum temperature of 250 deg F (121 deg C).
3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide, except where infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat.
2. Offset longitudinal joints in successive courses a minimum of 6 inches (150 mm).
3. Offset transverse joints in successive courses a minimum of 24 inches (600 mm).
4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's "The Asphalt Handbook."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 1559, but not less than 94 percent nor greater than 100 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch (13 mm).
2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch (6 mm).
2. Surface Course: 1/8 inch (3 mm).
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

3.8 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to cure for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

E. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D 979.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 32 1216

SECTION 32 1313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Curbs and gutters.
2. Walks.
3. Detectable warning pavers.

B. Related Sections:

1. Section 03 3000 "Cast-in-Place Concrete" for general building applications of concrete and for retaining walls.
2. Section 32 1373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

C. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

1. Detectable warning pavers.

D. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of detectable warnings and ready-mix concrete manufacturer.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Fiber reinforcement.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent.
7. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

1.6 QUALITY ASSURANCE

A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. ACI Publications: Comply with ACI 301 unless otherwise indicated.

D. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete paving subcontractor.
e. Manufacturer's representative of stamped concrete paving system used for detectable warnings.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type I/II. Supplement with the following:

a. Fly Ash: ASTM C 618, Class C or Class F.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.3 FIBER REINFORCEMENT

A. Synthetic Fiber: Virgin monofilament polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Virgin Monofilament Fibers:

1) Axim Italcementi Group, Inc.; FIBRASOL II P.
2) Euclid Chemical Company (The), an RPM company; Fiberstrand 150.
3) FORTA Corporation; FORTA Mighty-Mono.
4) Grace, W. R. & Co. - Conn.; Grace MicroFiber.
5) Metalcrete Industries; Polystrand 1000.

2.4 CONCRETE PAVING TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic lithium silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Convergent Technologies, LLC.; Pentra-Sil (NL).
b. Prosoco, Inc.; Consolideck LS

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.

b. BASF Construction Chemicals, LLC; Confilm.
c. ChemMasters; Spray-Film.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; VaporAid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation, Inc.; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Anti-Hydro International, Inc.; A-H Curing Compound #2 DR WB.
b. ChemMasters; Safe-Cure Clear.
c. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
d. Edoco by Dayton Superior; DSSCC Clear Resin Cure.
e. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
f. Kaufman Products, Inc.; Thinfilm 420.
g. Lambert Corporation; AQUA KURE - CLEAR.
h. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
i. Nox-Crete Products Group; Resin Cure E.
j. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 DETECTABLE WARNING PAVER MATERIALS

A. Detectable Warning Paver Units: Matte finish, cast-in-place (non-removable) composite solid body tactile warning surface units manufactured of precast concrete or exterior grade, homogeneous glass and carbon reinforced composite material.

1. Color: Uniform color and UV stabilization throughout thickness of unit. Do not use product that requires coating. Provide color as selected by Architect from manufacturer's full range.
2. Truncated domes: Square grid pattern, truncated domes of following dimensions:

   a. Height: 0.2 inches nominal height above surface of unit.
   b. Diameter: 0.9 inches at base and 0.45 inches at top of dome.
   c. Spacing: 1.67 inches to 2.35 inches from center to center in both grid directions.

3. Field Area: Non-slip, textured surface with minimum static coefficient of friction of 0.8, wet and dry.
4. Anchorage: manufacturer's standard corrosion-resistant anchors for anchoring units to substrate.

   a. If fasteners are exposed, locate fasteners between truncated domes as per manufacturer's recommendations.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.5.
3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1 percent for 1-1/2-inch nominal maximum aggregate size.
2. Air Content: 6.5 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture, high-range, water-reducing admixture, high-range, water-reducing and retarding admixture, or plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 10 percent.

G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 4.7 lbs/cu. yd.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Provide tie bars at sides of paving strips where indicated.
2. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of

contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

L. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

M. Concrete Paving Thicknesses:

1. Areas Subject to Pedestrian Traffic: Minimum 4 inches concrete over minimum 8 inch base.
2. Areas Subject to Vehicular Traffic: Minimum 6 inches concrete over minimum 12 inch base.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.7 DETECTABLE WARNING PAVER UNITS

A. Blockouts: Form blockouts in concrete for installation of detectable paving units.

1. Tolerance for Opening Size: Plus 1/4 inch, no minus.

B. Detectable Warning Paver Units: Install detectable warning paver units according to manufacturer's written instructions.

1. Do not install detectable warning paver units with chips, cracks, and other defects that may be detrimental to the safety or aesthetic qualities of the finished job.
2. Place detectable warning paver units before initial set of concrete bed. Tamp detectable warning paver units and beat in for a complete contact with setting bed. Set and level each detectable warning paver unit in a single operation.
3. Set detectable warning paver units in pattern indicated, with varying joint widths as necessary to align the centerlines of joints with a 1 foot module and with the centerlines of concrete scoring joints, concrete construction joints, concrete control joints, and concrete expansion joints.
4. Place detectable warning paver units firmly on concrete bed in a manner assuring a minimum of 95 percent contact. Do not vary surface plane of detectable warning paver units more than 1/8 inch plus or minus from the designed grade at any point.
5. Install expansion joints where detectable warning paver units abut restraining surfaces, such as perimeter walls, curbs, and directly over cold joints and control joints in structural surfaces.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by one of the following or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 LIQUID PAVING TREATMENTS

A. Penetrating Liquid Paving Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
2. Apply immediately following final concrete finishing operations as soon as the concrete is firm enough to work on unless otherwise advised by floor treatment manufacturer.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
4. Achieve waterproofing, hardening, dustproofing, and abrasion resistance of the surfaces without changing the natural appearance of the material, except for a latent waxy sheen on smooth troweled surfaces.
5. Apply specified liquid floor treatment to all interior exposed concrete floor slabs.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing on curbs, gutters, and sidewalks will not be required.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

SECTION 32 1373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Joint-sealant backer materials.

B. Related Requirements:

1. Section 07 9200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of joint sealant and accessory.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Urethane Joint Sealant: Federal specification TT-S-0023C, Type II, Class A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Building Systems; Sonolastic NP1.
b. Sika Corporation, Construction Products Division; Sikaflex - 1a.
c. Tremco Incorporated; Vulkem 116.

2.3 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such

protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.

1. Joint Location:

a. Expansion and isolation joints in cast-in-place concrete pavement.
b. Contraction joints in cast-in-place concrete slabs.
c. Other joints as indicated.

2. Urethane Joint Sealant: Single component, nonsag, Class 25.
3. Joint-Sealant Color: Color matching existing.

END OF SECTION 32 1373

SECTION 32 8000 - LANDSCAPE IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall construct an automatic irrigation system, complete and operable, in accordance with the requirements of the Contract Documents.

B. Said irrigation system shall include but not be limited to all pipes, fittings, irrigation heads, valves, automatic control valves, sensors, controllers, filters, backflow preventer, rain gauges, valve boxes, drain valves, quick coupler valves, operating wrenches, riser assemblies, direct burial wires, electrical connections, wiring and other appurtenances, piping, connens, testing, cleaning-up, maintenance and adjustments necessary for a complete operating system, ready for immediate use upon completion. Minor items necessary for proper construction and functional operation of this system, not specifically described in the Contract Documents, shall be included as a part of the work of this Section.

C. The Section cross references the following sections:

1. Division 01 Section “Contractor Submittals”
2. Division 32 “Landscape Maintenance Quality Standards”
3. Division 32 “Landscape Planting”
4. Division 22 “Plumbing”

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are as specified in Division 01.

B. Commercial Standards:

ASTM B 3	Specification for Soft or Annealed Copper Wire
ASTM D2564	Specification for Solvent Cements for Poly (VinylChloride) (PVC) Plastic Pipe and Fittings
AWWA C 500	Gate Valves for Water and Sewerage Systems

1.3 CONTRACTOR SUBMITTALS

A. Manufacturer's literature, samples (where requested by the LANDSCAPE ARCHITECT, HERE IN REFERRED TO AS L.A.), and installation instructions shall be submitted in accordance with Division 01 Section “Contractor Submittals."

B. Record drawings, showing actual locations of all valves, pipes (lines), heads, dimensions, controllers, control lines, and electrical wires shall be submitted prior to final inspection. Diagrammatic location of irrigation system components is not acceptable when submitting

record drawings – actual location of irrigation system equipment is required for locating in the field.

1. Actual routing of mainline with dimensions from fixed points.
2. Actual routing of control wiring with dimensions from fixed points.
3. Location of wire splices (must be placed in valve box and only used splices in approved locations)
4. Actual routing of lateral lines and head locations
5. Actual location of valve boxes with notes on type of valve used at each location.
6. Actual location of sleeves with dimensions from fixed points.
7. Actual location of stubbed mainlines or lateral lines (if applicable)
8. Actual location of sensors and associated wiring (i.e. rain gauge, ET sensors, etc.)
9. Provide legend of symbols/notes used on record drawings.
10. Any other notes as necessary to enable the owner to understand and locate irrigation system equipment in the field upon completion of the project.

C. Equipment for Operation: The CONTRACTOR shall provide the following equipment, in addition to what is indicated on the Drawings.

1. One Gate valve key.
2. Two keys for locking valve boxes.
3. 2 Valve Keys for Quick Coupler – coordinate with Owner.
4. One Valve Key for Manual Drain Valve.

D. A reduced copy of the irrigation plan shall be laminated and mounted in the controllers.

1.4 QUALITY ASSURANCE

A. In addition to other inspections, as provided by the L.A. and or OWNER, the CONTRACTOR shall give at least 72 hours notice to the L.A. for scheduling the following special inspections:

1. Layout of the system including specific locations of filters, backflow prevention devices, controller, rain gauge, and valve boxes.
2. Inspection of trenches, backfilling, and equipment.
3. Pressure tests
4. Coverage adjustment
5. Automatic operation

B. The CONTRACTOR shall notify the L.A. at least 72 hours prior to performing the tests. All tests shall be performed in the presence of the L.A. Test requirements shall be as follows:

1. After assembly and installation, all water pipes, fittings, automatic equipment, and appurtenances shall be tested at a hydrostatic pressure of 150 psi at the lowest point of the system for not less than 60 minutes.
2. The first test shall be made in such a manner that all valves in the new water pipe irrigation lines will be tested for watertight closure. Valves may be tested in groups or singly while subjected to 150 psi water pressure for a period of not less than 60 minutes.
3. The second test shall be made by forcing all air from the pipes with water and capping or plugging pipe risers. After the pipe risers have been plugged or capped, all line valves shall be fully opened and the pipe lines subjected to the full static water pressure for a period of not less than 120 minutes. Pressure pipelines 150 PSI).
4. The third test required that lateral lines be tested at 100 psi for 120 minutes.
5. The fourth test requires that all pressure lines be tested at 120 psi for 24 hours.
6. Water lines and valves which show evidence of leakage or fail to be watertight shall be repaired or replaced. After all repairs or replacements have been made, the above-required tests shall be performed again.
7. When the irrigation system is completed, the CONTRACTOR, in the presence of the L.A., shall perform test coverage of water afforded the lawn and planting areas. The CONTRACTOR shall furnish all material and perform all work required to correct any inadequacies of coverage disclosed. The CONTRACTOR shall inform the L.A. of any deviation from the Drawings required due to wind, planting, soil, or site conditions that bear on proper coverage.
8. Upon completion of each phase of the work, the CONTRACTOR shall check and adjust each irrigation head to meet the site requirements and the requirements of the Contract Documents.

   (Testing as noted in tests 2 through 5 is at the owner’s option, and generally will not be required unless verification of the contractor’s workmanship and quality is required.)

1.5 INSTRUCTION

A. The CONTRACTOR shall, upon completion of the maintenance period of the irrigation instruct the OWNER and the OWNER'S personnel as to the proper operation and maintenance of the system.

1.6 EXISTING UTILITIES AND CONDITIONS

A. Prior to cutting into the soil, the CONTRACTOR shall locate all cables, conduits, sewers, septic tanks, and other such underground utilities, and shall take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, the CONTRACTOR shall promptly notify the L.A.

B. The CONTRACTOR shall be responsible for coordinating its work with the operation of existing utilities and new utilities on the Project. The CONTRACTOR shall notify the L.A. or its representative when utilities which are in operation require shut-off.

C. Due to the scale of Drawings, it is not possible to indicate all offset, fittings, etc., which may be required. The CONTRACTOR shall carefully investigate the structural and finished conditions affecting all its work, and plan its work accordingly, furnishing such fittings, etc., as may be required to meet such conditions. The Contract Documents are generally diagrammatic and indicative of the work to be installed. The work shall be installed in the most direct and workmanlike manner, so that conflicts between irrigation systems, planting, structures, piping, and etc. will be avoided.

D. The CONTRACTOR shall verify the water pressure available at the site before installation of the system to make sure there is adequate pressure to properly operate irrigation heads and valves, and shall also provide pressure reducing valves if required before commencement of any work. Minor additions and adjustments of heads, piping, and circuits shall be made at no additional cost to OWNER where it is necessary to make the irrigation system operate properly.

1.7 STORAGE OF MATERIALS

A. The CONTRACTOR shall be responsible for storage of materials and for damage to the WORK covered by these Contract Documents before final acceptance of its work. The CONTRACTOR shall securely cover openings into the system, and shall cover all apparatus, equipment, and appliances both before and after being set in place to prevent obstruction in the pipes and the breakage, misuse, or disfigurement of said apparatus, equipment, or appliances.

1.8 SCHEDULING AND COORDINATION

A. The CONTRACTOR shall be responsible for making arrangements for the coordination of its construction operations with those of all others on the job. The CONTRACTOR shall permit others engaged in work to accomplish their portion of the WORK without undue interference or delay.

B. The CONTRACTOR shall be responsible for the scheduling and coordination of the electrical and water connections and the installation of the piping and equipment in a manner that will affect the earliest completion of the WORK in conformance with the construction progress schedules.

C. If electrical service is not already in place, the Contractor will be required to make all necessary arrangements with the power utility company including, but not limited to, paying fees, making power connections, providing poles, weatherhead and meter, etc., as specified on the plans. All permits, fees, and compliance with electrical company requirements, shall be the Contractor's responsibility.

1.9 GUARANTEE/WARRANTY OF THE IRRIGATION SYSTEM

A. The CONTRACTOR shall guarantee the complete irrigation system to be free from leaks or breakage due to defective material or workmanship for a period of one year from the date of acceptance of the complete work by the OWNER. Damage due to sabotage and/or vandalism is specifically accepted from this guarantee.

B. Other items of the required guarantee shall be as specified in the Division 32 Section "Landscape Planting" and "Landscape Maintenance Quality Standards"

C. The CONTRACTOR shall repair any settling of backfilling trenches occurring during a one year period after final acceptance without expense to the OWNER including complete restoration of all damaged planting, paving, or other improvements of any kind.

D. The CONTRACTOR shall provide winterization of the irrigation system during the one year guarantee period.

E. When defective material or workmanship is discovered which will require repair or replacement, all such repair work or replacement work shall be done by the CONTRACTOR at its own expense within 24 hours after written notification is given to the CONTRACTOR by the OWNER of such required repairs. However, if the CONTRACTOR fails to comply with the requirements of the above guarantee within the 24 hours after notification is given, the OWNER shall proceed to have the repairs made by others at the CONTRACTOR'S expense.

PART 2 - PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall furnish, at no additional charge, all samples necessary for testing as outlined in the Specifications or, when requested, certified evidence of off-site testing

B. The electrical point of connection for the irrigation system automatic controller shall be 120-volt building electrical supply or as per manufacturer's recommendations.

2.2 PLASTIC PIPE AND FITTINGS

A. Pipe shall be continuously and permanently marked with the following information: manufacturer's name, nominal pipe size, PVC type, pressure rating, and extrusion date.

C. All plastic pipes for lateral lines shall be PVC (polyvinyl chloride) SDR 21, Schedule 40, Schedule 80, NSF approved.

D. Materials for pressure main lines shall be PVC (polyvinyl chloride) SDR 21, Schedule 40, Schedule 80, or NSF approved.

E. All fittings shall be PVC (polyvinyl chloride) Schedule 40, Type II, NSF, and Schedule 80 mainline fitting up to valve on mainline as called for in the Contract Documents, see Drawings.

F. Ductile iron fitting shall be grade 65-45-12 in accordance with ASTM A-536. Fitting shall be deep bell push-on joints with gaskets meeting ASTM F-477. Fittings shall be Harco Deep Bell or approved equal. Transition gaskets are not allowed.

G. Swing joint ells and nipples shall be Schedule 80 PVC or as noted on Drawings.

2.3 VALVES

A. Isolation valves for valve manifolds shall be shall be as indicated on the Drawings.

B. Remote Control Valves shall be as indicated on the Drawings.

1. Each group of remote control valve shall be housed in a poly plastic valve box with locking lid and gravel base.

C. Quick-coupling valves shall be as indicated on the Drawings.

2.4 AUTOMATIC CONTROLLER

A. Automatic Controllers shall be as indicated on the Drawings.

2.5 CONTROL WIRING

A. Control wire shall be Standard PE Direct Burial Copper Wire, Type UF Bearing, UL approved for direct underground burial in National Electrical Code Class II circuits, AWG sizes.

B. Conductor of electrical conductivity shall be grade copper meeting requirement of ASTM B 3

C. All splices shall be made with wire connectors, such as manufactured by Rain Bird, Scotch Lock, 3M DBY or approved equal.

2.6 PVC SOLVENT CEMENT AND PRIMERS

A. Solvent Cement shall be NSF approved and shall meet requirements of ASTM D 2564.

B. Primer shall be NSF approved and shall be Weld-On, P-70 Industrial Polychemical Service or approved equal.

2.7 VALVE AND CONTROLLER BOXES

A. Boxes for valves shall be heavy duty plastic Rain Bird, Carson-Brooks, complete with locking lids, or approved equal.

B. Boxes and lids shall match surrounding ground as follows:

1. Shrub/Perennial Beds with Bark Mulch or Tan Rock Mulch: Tan
2. Turfgrass / Seeded areas: Green

2.8 OTHER MATERIALS

A. Other materials required or necessary shall be as shown and/or as required for best quality work.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of the irrigation system shall be performed after the finish grading, but prior to landscaping.

B. Connect the proposed irrigation system to portions of two existing irrigation mainlines as indicated on the drawings. The CONTRACTOR shall verify the location of existing irrigation equipment and report any discrepancies between proposed improvements and the irrigation system to the owner's representative prior to commencing work.

C. All valves, fittings, heads, and piping shall be installed as indicated on the Drawings and all connections made to permit the irrigation system to function properly through its entire length.

D. All materials and equipment shall be installed in strict accordance with manufacturer's written instructions and recommendations and all local and state codes, laws, ordinances, and regulations.

E. Before proceeding with the installation of any section or unit of the irrigation system, the CONTRACTOR shall check and verify the correlation between ground measurements and Drawings and shall advise the L.A. of any discrepancies.

F. The total number of irrigation heads and circuits and size of pipes shall be not less than shown unless otherwise approved. The stated maximum spacing for each type of irrigation head shall not be exceeded.

3.2 EXCAVATION

A. Trenches shall be dug as wide and as deep as necessary to properly install the irrigation pipe.

B. Pipe trenches shall be straight, or "snaked" slightly allowing for expansion and contraction of PVC pipe.

C. Subsoil shall be kept separate from topsoil, where possible.

D. Minimum cover depth shall be as follows:

1. Supply pressure lines from water source to control valves: 24 to 30 inches unless otherwise indicated on the Drawings.

2. Lateral lines from control valves to irrigation heads; 8 and 16 inches unless otherwise indicated on the Drawings. Lateral lines under paving, roadways, and driveways shall have 18 inches of cover and located in Schedule 40 PVC sleeves

3. Trenches for control wire only shall be 24 to 30 inches deep unless otherwise indicated on the Drawings. Control wires under concrete walks and slabs, paving, roadways, and driveways shall be installed in Schedule 40 PVC sleeves.

E. A trench of sufficient width shall be provided to allow for proper tamping around pipe.

3.3 PIPING-GENERAL

A. Piping shall be laid out and installed in accordance with manufacturer's printed recommendations and industry standards. Substantial support shall be provided at all points, and pipes shall be snaked slightly allowing for expansion and contraction.

B. Minimum 1-inch vertical clearance shall be between lines crossing at angles greater than 45 degrees.

C. Minimum 3 inches horizontal and vertical clearances shall be between all other lines.

D. All swing or swivel joints shall provide a leak-resistant joint with freedom of movement.

E. Teflon thread sealant 3/4-inch wide (tape or liquid), or approved equal shall be used at all threaded joints.

F. Pipe sleeves shall be provided under all paving and where necessary for passage under finish surface material, future replacement, and for protection of PVC piping and control wire.

3.4 PLASTIC PIPE

A. The pipe shall be guaranteed by the manufacturer to be suitable for operation under the conditions of this installation and shall be guaranteed free from defects in workmanship and quality.

B. The pipe shall be connected by O-ring type or by solvent-weld joints as outlined below. Joints shall be made in strict accordance with the manufacturer's printed recommendation.

C. The plastic pipe sections shall be placed accurately to line and grade in the prepared trenches. The inside of all pipe shall be clean and free from foreign matter and shall be end-reamed to remove burrs and provide full inside diameter of the nine end.

D. Pipe assembly shall have a firm, uniform bearing for the entire length of each pipeline to prevent uneven settlement. All adjustments to grade shall be made by scraping away or filling in with clean earth backfill material, well compacted under the body of the pipe. Wedging of pipe will not be permitted. The inside of all pipes shall be clean and free from foreign materials before joints are assembled.

E. Sealant tape shall be used on all threaded joints.

F. All pipeline open ends upon which the WORK has been stopped shall be closed at the end of each day's construction work with a suitable temporary plug to prevent entrance of any foreign materials into the assembled pipeline.

G. Pressure pipe shall be defined as all piping lying "upstream" from remote control valves and quick-coupling lines.

H. O-Ring type flexible coupling pipe shall be used on pressure pipes 4-inch diameter and larger.

I. Three inch and smaller mainlines and fittings of pressure piping shall be solvent-weld type.

J. Pressure piping 3-inch and larger shall be provided with Portland cement concrete thrust blocks. Thrust blocks shall be constructed at the following places:

1. Where pipe changes direction at fittings.
2. Where pipe changes size.
3. Where line terminates.

K. Thrust blocks shall be constructed of 2000 psi concrete, as noted on Drawings and details.

L. The areas noted on the details table shall be measured in a place perpendicular to the longitudinal axis of the pipe or to the longitudinal axis of the thrust developed. The thrust block bearing area shall be against undisturbed around.

M. Compression fitting (compression by compression slip joint PVC) shall be provided on mainline at 250 on center for expansion and contraction of mainline on straight runs on solvent welded pipe.

3.5 VALVES

A. Piping systems shall be supplied with valves at all points as indicated on the Drawings or specified herein so arranged to give complete regulating control throughout. Automatic control valves and gate valves, shall be as detailed in the Contract Documents or as otherwise directed by the L.A..

B. Valves shall be the full size of the line in which they are installed, unless otherwise indicated on the Drawings.

C. Remote control valves shall be adjusted so the most remote irrigation heads operate at the pressure recommended by the head manufacturer. Remote control valves shall be adjusted so a uniform distribution of water is applied by the irrigation heads to the planting areas for each individual valve system. A union fitting shall be provided on the discharge side of the control valve. They shall be wired to operate in the order as shown. They shall be capable of being operated manually entirely independent of the controller.

D. Isolation shall be installed as indicated on the Drawings.

E. Quick-coupling valves shall be provided, located, and installed as indicated on the Drawings.

3.6 VALVE BOXES

A. All valve assemblies shall be installed as indicated on the Drawings.

B. Boxes and lids shall match surrounding ground as follows:

1. Shrub/Perennial Beds with Bark Mulch or Tan Rock Mulch: Tan
2. Turfgrass / Seeded areas: Green

C. Except in rare instances, valve boxes shall be located in shrub/perennial beds as approved by the L.A.

3.7 IRRIGATION HEADS

A. All nozzles on irrigations shall be tightened after installation. All irrigations having an adjustment stem shall be adjusted on a lateral line for the proper radius diameter and/or flow

B. All irrigation heads shall be set perpendicular to finished grades and at finish ground level.

C. All irrigation heads shall be installed as detailed on the Drawings.

D. The irrigation system shall be thoroughly flushed remove all possible foreign material prior to installation of the irrigation heads.

E. The CONTRACTOR shall protect against re-entry of contaminated water into risers or piping. After flushing, the CONTRACTOR shall immediately install irrigation heads or cap risers until irrigation heads are installed.

3.8 CONTROLLER

A. The CONTRACTOR shall connect existing & proposed valves to proposed controllers per manufacturer’s recommendations. Provide surge and lightning protection equipments per the manufacturer’s recommendations.

3.9 WIRING AND ELECTRICAL WORK

A. All electrical equipment and wiring shall comply with local and state codes and shall be installed by those skilled and licensed in the trade. Unless the governing codes specify otherwise, low voltage control wire may be installed by the CONTRACTOR when code allows.

B. All 110-volt wire shall be installed in conduit and taken from appropriate sources as indicated on the Drawings. CONTRACTOR shall coordinate manufacturer and installer

C. The CONTRACTOR shall provide low voltage, 24-volt direct burial wires. Wire size shall be as shown but shall be not less than No. 14. Where sizes are not shown, they shall be sized per wire manufacturer's sizing charts and specifications.

D. The CONTRACTOR shall provide all wiring, conduits, sleeves, and connections between controller and valves, and where else shown and necessary for a complete and operable irrigation system.

E. All splices shall be moisture proof using specified electrical connectors.

F. An expansion curl should be provided within 3 ft of each wire connection and at pull box locations. Provide three feet of extra wire in each valve box.

G. All conduits and sleeves necessary for running wires under concrete, walks, and paving shall be furnished and installed before said concrete, walks, and paving work is installed.

H. Wire shall be continuous without splices except at control valves, and shall be routed in main line trench whenever possible.

I. The CONTRACTOR shall connect existing & proposed valves to existing controllers per manufacturer's recommendations.

3.10 PIPE TRENCH BACKFILL

A. After pipe and wires have been installed, the trenches shall be backfilled. The backfill operation must provide a firm continuous support for the pipe.

B. Backfill material shall be free of rocks and other materials that may damage the piping.

C. Bottom of trenches shall be smooth and free of sharp rocks and other object that may damage pipe.

D. The initial backfill shall be accomplished by carefully tamping selected material (from material excavated from the trench) under the pipe and between the pipe and the trench.

E. The pipes shall be filled with water and pressurized during backfilling operations if necessary, to prevent drainage to piping.

F. The backfill shall be carefully installed around and over the pipe to approximately 10 inches of the ground surface, then water shall be allowed to flow in the trench. After this puddling operation has been completed and allowed to stand for 24 hours, the balance of the materials shall be placed in the trench to the sub-grade line (leaving room for topsoil) Rocks and other materials found in the backfill shall be removed. The backfill shall be compacted carefully and thoroughly.

G. Couplings and fittings shall be left exposed until leakage tests have been completed.

H. Install detectable warning tape as indicated on the Drawings.

3.11 TESTING AND ADJUSTMENTS

A. The L.A. shall be notified by the CONTRACTOR prior to performing hydrostatic tests on the irrigation system in place. This test shall be done by the CONTRACTOR in the presence of the L.A. The test results will be acceptable to the L.A. when no leakage or loss of pressure is evident during the test period. Defects shall be detected and repaired prior to retesting.

B. The irrigation heads shall be adjusted and balanced for optimum and uniform coverage without excessive fogging and overthrow on walks, paving, and structures. The height and elevations of risers and irrigation heads shall be adjusted.

C. Following adjusting and balancing of the irrigation heads, an operating test of the entire system shall be performed by the CONTRACTOR in the presence of the L.A. at normal operating pressures. The test will be considered as acceptable if the system operates in a satisfactory manner providing uniform coverage of irrigated areas for a one week period of automatic operation with no leaks.

3.12 RECORD DRAWINGS

A. Record Drawings shall be furnished to the L.A. at the time of the irrigation system inspection and before acceptance of the operating system by the OWNER. Refer to Section 32 8000.1.3.

3.13 ACCEPTANCE AND OPERATION BY OWNER

A. Upon substantial completion of the work and acceptance by the Owner, the Engineer will issue a date of substantial completion letter to the contractor. Contractor shall be responsible for the training of the owner’s maintenance staff in the operation of the system (provide minimum 48 hours written notice in advance of test). The Contractor shall furnish, in addition to the Record Drawings and operational manuals, copies of all available specification sheets and catalog sheets to the Owner's personnel responsible for the operation of the irrigation system. The Contractor shall guarantee all parts and labor for a minimum period of one (1) year from date of substantial completion.

END OF SECTION 32 8000

SECTION 32 9300

LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall perform all the landscaping and all appurtenant work, complete, in accordance with the requirements of the Contract Documents.

B. Scope of Work: Landscaping as referred to herein shall include, but not be limited to the following work: soil preparation, weed control, finish grading, furnishing and installing plant materials, tree staking and tying, cleanup, maintenance, and guarantee.

C. The Section cross references the following sections:
1. Division 01 Section “Contractor Submittals”
2. Division 01 Section “Project Closeout”
3. Division 32 Section “Landscape Irrigation System”

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications:
1. FS O-F-241 D Fertilizer, Mixed, Commercial

B. Commercial Standards:
1. ANSI/ASTM D 422 Method for Particle-Size Analysis of Soils
2. ANSI Z601 Nursery Stock
3. American Association of Rules and Grading Provisions Nurserymen, Inc.

1.3 CONTRACTOR SUBMITTALS

A. General: The CONTRACTOR shall furnish a certificate with each delivery or bulk material delivery, stating source, quantity, and type of material. All materials shall conform to specification requirements. All certificates shall be delivered to the LANDSCAPE ARCHITECT (here in referred to as L.A.) at time of each delivery. All bulk delivered materials shall be delivered with level load volume plainly marked on the truck bed.

B. Submittals required shall be submitted as specified in Division 01 Section “Contractor Submittals”:
1. Topsoil Report: Literature.
2. Literature on Fertilizers and Additives: Literature.
3. Bark Mulch: Literature and ½ gallon sample.
4. Staking Materials: Literature.
5. Sod mix: Literature.
6. Plant Material: Photos of actual plant material, not stock photos.

1.4 QUALITY ASSURANCE

A. General: All plants furnished by the CONTRACTOR shall be true to type or name as shown in the Contract Documents and shall be tagged in accordance with the standard practice recommended by the Agricultural Code of the State of Utah; however, determination of plant species or variety will be made by the L.A..

B. All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and certificates shall be delivered to the L.A..

C. All inspections herein specified will be made by the L.A. or its representative. The CONTRACTOR shall request inspection at least 24 hours in advance of the time inspection is required. Inspection will be required on the following stages of the WORK:
   1. During preliminary grading, soil preparation, and initial weeding.
   2. When trees are spotted for planting, but before planting holes have been excavated.
   3. When finish grading has been completed.
   4. When all specified work, except the maintenance period has been completed.
   5. Final inspection at the completion of the maintenance period.

D. Plants shall be subject to inspection and approval or rejection by the L.A. at place of growth and upon delivery to the site at any time before or during progress of the WORK and according to:
   1. Quantity, quality, size, and variety;
   2. Ball and root condition; and
   3. Latent defects and injuries resulting from handling, disease, and insects.

E. Plants approved at pre-planting inspection shall still be subject to rejection during planting if found to be below Specifications.

F. Rejected plants shall be identified in an obvious manner, promptly removed from the site and replaced with acceptable equals.

G. Plants shall have been grown in nurseries which have been inspected by the governing authorities. Inspection of plant materials required by City, County, State, or Federal authorities shall be the responsibility of the CONTRACTOR, who shall have secured permits or certificates prior to delivery of plants to site.

1.5 CLEANUP

A. Upon completion of all planting operations, the portion of the project site used for a work or storage area by the CONTRACTOR shall be cleaned of all debris, superfluous materials, and equipment. All such materials and equipment shall be entirely removed from the project site as specified in Division 01 Section “Project Closeout”.

B. All walks or pavement shall be swept or washed clean upon completion of the work of this Section.

C. During the entire Contract period, plant containers that have been cut or removed from plant materials shall be removed from the project site daily, in accordance with the provisions for maintenance and guarantee as specified in Division 01 Section "Project Closeout".

1.6 MAINTENANCE OF LANDSCAPE PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. General: The CONTRACTOR shall be responsible for protecting, watering, and maintaining all planting and irrigation systems until final acceptance of all work under the contract.

B. At time of acceptance of the complete project, the lawn shall be totally established with no bare spots, mowed a minimum of 2 times, and the grass shall be at least 1-1/4 to 2 inches in height.

C. Watering: Trees and shrubs shall be thoroughly soaked after planting and provided with additional water at intervals as necessary to provide for good health and growth of the planting.

D. Upon completion of lawn sodding, the entire area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by the irrigation system existing on the site during dry weather or whenever necessary for proper establishment of the lawn. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR at its own expense.

E. Protection: The CONTRACTOR shall provide adequate protection to all newly planted areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until acceptance.

F. The CONTRACTOR shall replace any materials or equipment it has damaged or which has been damaged by its employees or subcontractors.

G. Partial utilization of the project shall not relieve the CONTRACTOR of any of the requirements contained in the Contract Documents.

H. Mowing of Lawn Areas: First mowing of lawn areas shall begin as soon as the grass has reached a height of 3 inches and subsequent mowing shall be at least once a week, or as often as necessary to maintain all lawn areas at a uniform height of 1-1/2 to 2 inches.

I. All lawns shall be fertilized every 3 weeks with 6 lb of 16-8-8 commercial fertilizer per 1000 sq ft for the first 7 weeks and fertilized thereafter once each 5 months prior to acceptance.

J. Plants shall be maintained in a vigorous, thriving condition by watering, cultivating, weeding, pruning, spraying, and other operations necessary. No trees or shrubs will be accepted unless they are healthy and show satisfactory foliage conditions.

K. All planted areas shall be cultivated at least every 2 weeks and raked smooth, to present a neat appearance and additional mulch shall be added where necessary.

L. Maintenance shall include, in addition to the foregoing, weed control, cleaning, edging, repairs to stakes, wire, and wrappings, the repair of erosion, and all other necessary work of

maintenance. Sidewalks and other paved areas shall be kept clean while planting and maintenance are in progress.

M. Any and all irrigation lines broken or disrupted during this construction shall be replaced to proper working order prior to contract work and be acceptable to the OWNER.

1.7 FINAL INSPECTION AND GUARANTEE

A. Inspection of work of lawns and planting will be made at conclusion of maintenance.

B. Written notice requesting inspection shall be submitted to the L.A. at least 10 days prior to the anticipated inspection date.

C. Final acceptance of the WORK prior to guarantee period of the contract will be accepted upon written approval by the L.A., on the satisfactory completion of all work, including maintenance, but exclusive of the replacement of plant material.

D. Any delay in the completion of any item of work in the planting operation which extends the planting into more than one season shall extend the guarantee in accordance with the date of completion given above.

E. The CONTRACTOR shall replace, as soon as weather conditions permit, all dead plants and all plants not in a vigorous, thriving condition which are noted at the end of the one year guarantee period.

F. Plants used for replacement shall be of the same size and variety specified in the plant list. Plants shall be furnished, planted, staked, and mulched as specified.

G. All work done under this contract shall be left in good order to the satisfaction of the OWNER and the L.A. and the CONTRACTOR shall, without additional expense to the OWNER, replace any trees, shrubs, etc., which develop defects or die during the one-year guarantee period.

1.8 GUARANTEE FOLLOWING ACCEPTANCE OF PROJECT

A. General: The CONTRACTOR shall be responsible for a period of one year after date of acceptance of all work under the Contract, for all necessary plant or tree replacements. The CONTRACTOR shall provide a written guarantee to the OWNER from the landscaping subcontractor, embodying the provisions of this Section of the Specifications.

B. The WORK covered by the guarantee portions of these specifications consists of providing all replacements of plants, labor, materials, equipment, and supplies and in performing all operations in connection with guarantees.

C. The CONTRACTOR shall clean-up and remove unused or waste materials from the site and leave the area in a neat condition (satisfactory to the OWNER) whenever it performs work during the guarantee Period.

D. Final Inspection: The OWNER and CONTRACTOR shall make a final inspection at the end of the one-year guarantee period. Any plants and materials found defective at time of final inspection shall be replaced within a time agreed upon by both parties. If it is too late in the planting season for replanting, the replacements shall be made during the next planting season even though such planting may run beyond the maintenance and correction period.

PART 2 - PRODUCTS

2.1 GENERAL

A. All landscaping materials for soil conditioning, weed abatement, or planting shall be first-grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or provided with each delivery. Delivery certificates shall be given to the L.A. as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the L.A. prior to the final acceptance of the job.

2.2 TERMINOLOGY AND QUALIFICATIONS

A. Plants or plant material having characteristics not conforming to terms as defined will not be accepted. The terms "plant material" or "plants" refer to all vegetation, whether trees, shrubs, ground cover, or herbaceous vegetation.

B. Quality refers to structure and form, as evidenced by density and number of canes and branches, compactness, symmetry, and general development without consideration of size or condition. Standard quality indicates the least acceptable quality. Plants shall be typical of the species and variety of good average uniform growth, shall be well formed and uniformly branched, and shall have the minimum number of canes specified, free from irregularities, or shall conform to minimum quality index. Where the number of canes is not specifically stated in describing this grade, the standards of the "Horticultural Standards" as adopted by the American Association of Nurserymen, shall apply. In this case, the number of canes and other factors for the appropriate classification under "quality definition" in the Horticultural Standards shall be the Quality index. Plant material below this standard will be considered "culls" and are not acceptable. Plants shall be nursery grown.

C. Specimen means an exceptionally heavy, symmetrical, tightly-knit plant, so trained or favored in its development and appearance as to be outstanding, superior in form, number of branches, compactness, and symmetry.

D. Size is the factor controlled by dimensions representing height or spread, or both, without consideration of quality or conditions. For standard quality, a dimension is given for height or container size, or a dimension is given for height as well as container size.

E. Height is usually indicated with a tolerance. The smaller dimension is the minimum acceptable. The larger dimension represents the maximum permissible. The average dimension of all plants must equal the average of the tolerance figures shown on each item

F. Condition is the factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity, at the same season of the

year. In addition, plants shall be free from physical damage or adverse conditions that would prevent thriving. Conditions also sometimes refer to state of growth, i.e., whether "dormant condition" or "growing condition" and this state shall be comparable to plants of similar species in the vicinity or leaves, formation of buds, and the like.

G. Cane means a primary stem which starts from the ground, or close to the ground, at a point not higher than 1/4 the height of the plant.

H. Caliber shall be taken 12 inches above the finish grade or ground, as a guide, or where a dimension in trunk appears to form the head of the tree.

I. Foliage line is maximum dimension in case of specimen plants. It measures from ground to lowest part of body of plant.

J. Collected plants shall not be used.

2.3 TOPSOIL

A. Imported topsoil borrow shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. Topsoil borrow shall be subject to inspection and approval at the source of supply and upon delivery.

B. The topsoil borrow shall be of uniform quality, free from subsoil stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. Topsoil borrow shall contain no noxious weeds or noxious weed seeds.

C. Topsoil borrow shall meet all specifications below for either “Ideal” or “Acceptable” categories. Soil that falls within the “Not-Acceptable” range shall not be used.

TOPSOIL QUALITY*

Category	pH	Soluble Salts dS/m or mmho/cm	Sodium Absorption Ratio (SAR)	Organic Matter %	Sand %	Silt %	Clay %	Texture Class
Ideal	5.5-7.5	<2	<3	≥2.0	<70	<70	<30	Loam (L), Silt Loam (SiL)
Acceptable	5.0-8.2	<4	3 to 7 SiL, SiCL, CL 3 to 10 SCL, SL, L	≥1.0	<70	<70	<30	Sandy Clay Loam (SCL) Sandy Loam (SL) Clay Loam (CL) Silty Clay Loam (SiCL)

Not-Acceptable	<5.0 >8.2	>4	>10	<1.0	≥70	≥70	≥30	Loamy Sand (LS) Sandy Clay (SC) Silty Clay (SiC) Sand (S), Silt (S), Clay (C)

COARSE FRAGMENTS*

Category	%>2 mm (>5.0% exceeds guidelines)	Rocks Present >1.5" (>1.5" exceeds guidelines)
Ideal	.2.0	—
Acceptable	2.1-5.0	—
Not-Acceptable	>5.0	—

TOPSOIL NUTRIENT SPECIFICATION*

	Nitrate Nitrogen ppm	Phosphorus ppm	Potassium ppm	Iron ppm
Ideal / Acceptable	>20	>15	>150	>10

*from "Topsoil Quality Guidelines for Landscaping", June 2002, AG/SO-02, prepared by Rich Koenig, Utah State University Cooperative Extension Soil Specialist, and Von Isaman, QA Consulting and Testing, LLC.

D. Mechanical Analysis shall be performed and shall conform to ANSI/ASTM D 422. QUALITY ASSURANCE.

2.4 COMPOST

A. Topsoil shall meet requirements listed above and be amended with 3 cubic yards of compost/1000 sq. ft. for every 3-inches of soil depth. Compost shall be incorporated into topsoil by rototilling. Compost shall meet all specifications below for either "Ideal" or "Acceptable" categories. Compost that falls within the "Not-Acceptable" range shall not be used.

COMPOST QUALITY GUIDELINES FOR LANDSCAPING*

	pH	**Soluble Salts dS/m**	**Sodium Absorption Ratio (SAR)**	**Carbon:Nitrogen Ratio (C:N)%**	**Moisture%**	**≥ 98% Coarse Material Passing (dry**
Ideal	6 to 8	≤5	<10	≤20:1	25 to 35	3/8"
Acceptable	5-6, 8-9	≤10	≤20	21:1 to 30:1	<25, >35	3/4"
Not-Acceptable	<5.0, >9.0	>10	>20	<10:1, >30:1	<20, >50	<98% 3/4"

*Von Isaman MS, Pres. Of QA Consulting and Testing, LLC., Dr. Rich Koenig, Utah State University Cooperative Extension Soils Specialist, and Dr. Teresa Cerny, USU Cooperative Extension Horticulturalist, 3 March 2003.

2.5 FERTILIZER AND ADDITIVES

A. Fertilizer and additives shall be determined by the Topsoil Analysis and based on section 2.3.

B. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.

C. Chemical fertilizers shall be a mixed commercial fertilizer conforming to FS O-F-241 D, Type I, with percentages of nitrogen, phosphoric acid, and potash at 5-10-5 and 16-16-8. The combined N-P-K content shall be following percentages of total weight: 5 percent nitrogen 10 percent phosphoric acid and 5 percent potash. Fertilizers shall be uniform in composition, dry, and free flowing.

D. Tablets shall be 21 grams each 20-10-5 Agriform, Lesslie, or approved equal.

2.6 MULCH

A. Bark Mulch: Shredded bark mulch in planting beds shall be clean, pine bark free of sticks and pieces over 2 inches in size produced by "chipping and shredding" tree branches or similar means, placed to depths as indicated on the drawings. Use around tree pits in turf areas.

2.7 PLANT MATERIALS

A. Plants shall meet requirements of the Contract Documents and shall be in accordance with the botanical names and applicable standards of quality, size, condition, and type. They shall be true to name, genera, species, and variety in accordance with reference publications.

B. Plant names are defined in "Standardized Plant Names" and "Bailey's Encyclopedia of Horticulture." When a name is not found in either reference, the accepted name used in the nursery trade shall apply.

C. Plants shall be marked for identification. Each bundle of plants and at least 25 percent of each species and variety of separate plants in any one shipment shall have legible labels securely attached before delivery to the site.

D. All trees and shrubs shall be measured while their branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch or root tip to tip. No trees will be accepted with their leaders cut, or so damaged that cutting is necessary.

E. All plants shall be symmetrical and shall conform to the size, age, and condition as specified on the plant list shown in the Contract Documents. Exceptions are as follows:
   1. Plants larger than specified in the plant list may be used if approved by the L.A., but use of such plants shall not increase the contract price. If the use of larger plants is approved, the spread of roots or ball earth shall be increased in proportion to the size of the plant. Bare root plants furnished in size greater than specified shall be balled and burlaped when required by the L.A.
   2. Where caliper or other dimensions of any plant materials are omitted from the Plant List, it shall be understood that such plant materials shall be normal stock for type

F. Plants shall be of sound health, vigorous, and free from plant disease and shall be well-branched, shall have full foliage when in leaf, and shall have a healthy well-developed normal root system. Cold storage plants will not be accepted. Plants that are sensitive to shock from elevation change shall be grown at elevations close enough to site to alleviate any plant damage due to such change for at least 2 years.

G. Bare rooted (BR) plants shall have well-developed branch systems and vigorous root systems. They shall be dug to sufficient depth to insure full recovery and development of the plants. Roots of these plants shall be covered with a uniformly thick coating of mud being puddled immediately after they are dug

H. Balled and burlaped (BB) plants shall have firm, natural balls of earth, or diameter not less than that specified and of sufficient depth to include all the fibrous and feeding roots. No plant moved with a ball will be accepted if the ball is cracked or broken before or during plant operations, except on special approval of the L.A.

I. Roots or balls of all plants shall be adequately protected at all times from sun and drying winds.

J. Plants (indicated to be in marked cans, pots, or other containers on the plant list) shall have been grown in the containers for a minimum of 6 months and a maximum of 2 years. Roots shall fill the containers but show no evidence of being or having been root bound.

K. Trees shall have straight trunks and all old abrasions and cuts shall be completely callused over. In no case shall trees be topped before delivery.

L. Plants shall have been transplanted or root-pruned at least once in the 2 years. Plants shall not be pruned prior to delivery except as authorized by the L.A..

2.8 SOD GRASS

A. The sod shall be nursery grown and as indicated on Drawings. It shall be uniformly cut approximately 3/4-inch or more thick and shall be well rooted, 2-year old growth of permanent and desirable grasses indigenous to this general location. The sod shall be practically free from weeds and undesirable grasses.
   1. Sod Type
      a. 'RTF' – All American Farms
      b. 'Imperial Blue' – Chansare Farms
      c. 'Bio-Blue' – Biograss Turf Farms

2.9 STAKING MATERIALS

A. Staking System: As indicated on Drawings

B. Guying System: As indicated on Drawings.

C. Flags: Standard surveyor's plastic flagging tape, white, 8 inches long.

PART 3 - EXECUTION

3.1 GENERAL

A. The landscape work shall not be performed at any time when it may be subject to damage by climatic conditions.

B. The CONTRACTOR shall verify all dimensions in the Contract Documents. Dimensions and plant locations shown shall be coordinated with L.A. and final location shall be site-oriented by the planter and L.A.. Any discrepancies or inconsistencies discovered shall be brought to the attention of the L.A..

C. In case of conflict between the plant list totals and total plant count of the Contract Documents, the CONTRACTOR shall provide the higher number of plants.

D. Delivery of materials may begin only after samples and tests have been approved by the L.A.. All materials furnished for the work shall be not less than the approved sample.

E. Substitutions for the indicated plant materials may be permitted pursuant to the Contract Documents.

F. The CONTRACTOR shall provide temporary fencing, barricades, covering, or other protections to preserve existing landscaping items indicated to remain and to protect the adjacent properties and other structures when they may be damaged by the landscape work. As indicated on Drawings.

G. Waste materials shall be removed and disposed of off the OWNER's property, unless otherwise indicated.

H. It shall be the responsibility of the CONTRACTOR to avail itself of any information regarding utilities which are in the area of work and to prevent damage to the same. The CONTRACTOR shall provide protection to the utilities as necessary.

I. Burning of combustible materials on the site shall not be permitted.

J. The CONTRACTOR shall provide protection to structures, sidewalks, pavements, and other facilities in areas of work which are subject to damage during landscape work. Open excavations shall be provide with barricades and warning lights which conform to the requirements of governing authorities and the State's OSHA safety requirements from dusk to dawn each day and when needed for safety.

K. Planting areas include all areas to be landscaped unless, specified or shown, otherwise.

3.2 SOIL PREPARATION

A. PRIOR to placement of topsoil and amending of topsoil, a Topsoil Report shall be performed for the existing site topsoil conditions and if used the imported topsoil. The existing and proposed topsoil shall be amended to meet the above specifications in Section 2.

B. The landscape work shall not begin until all other trades have repaired all areas of settlement, erosion, rutting, etc., and the soils have been re-established, re-compacted, and refinished to finish grades. The L.A. shall be notified of all areas which prevent the landscape work from being executed.

C. Areas requiring grading by the landscaper including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10-ft above or below required finish elevations.

D. The landscape work shall not proceed until after walks, curbs, pavings, edging, and irrigation systems are in place. The contract operations shall be completed to a point where the landscape areas will not be disturbed. The subgrade shall be cleaned free of waste materials of all kinds.

E. During grading waste materials in the planting areas such as weeds, rocks (1 inches and larger) building materials, rubble, wires, cans, glass, lumber, sticks, etc., shall be removed from the site. Weeds shall be dug out by the roots.

F. Fertilizers, additives, peat, etc. subject to moisture damage shall be kept in a weatherproof storage place in such a manner that they will be kept dry.

G. After removal of waste materials the planting areas subgrade shall be scarified and pulverized to a depth of not less than 6 inches and all surface irregularities below the cover of soil removed.

H. Finish subgrade and amended topsoil placement and grading shall consist of:
1. Prepare subgrade by rough grading and removing all irregularities and debris, then till and scarify subsoil to a depth of 6 inches before placing topsoil. Dig subgrade down as required in shrub beds, turf areas for the placement of amended topsoil. Provide laser leveling on large flat areas to create a uniform level subgrade.
2. Landscape contractor is responsible for the last 4 inches of grade in turf sod areas (3 inches of topsoil and 1 inch for sod) and 9 inches in shrub bed areas (3 inches of bark mulch and 6" of amended topsoil). All planting areas shall have all road base removed prior to placement of topsoil. Refer to grading plan for finish grade and drainage. Subgrade soil shall be in a loosened and rough surface finish before amended topsoil is placed over subgrade. (Sub-grade surface shall not be smooth, but a rough surface shall exist for a transition zone of amended topsoil to subsoil.) If areas of subgrade become compacted before amended topsoil is placed, subgrade shall be tilled again before amended topsoil placement.
3. Placing all amendments, soil additives and fertilizers for the areas as noted on the plan and per the topsoil report.
4. Till lawn and planting area subsoil's and topsoils that are compacted.
5. After tilling, bring areas to uniform grades by floating and/or hand raking. In large open level areas, perform laser leveling to create uniform level areas.
6. Make minor adjustment of finish grades as directed by the landscape architect or owner.
7. Remove waste materials over 1" in size such as stones, roots, or other undesirable foreign materials and finish raking, dishing, dragging, and smoothing soil ready for planting.
8. No grading or soil placement shall be undertaken when soils are wet or frozen

I. Any unusual subsoil condition that will require special treatment shall be reported to the L.A.

J. Amended topsoil shall be uniformly distributed over all areas where required. Subgrade and amended topsoil shall be damp and free from frost.

K. Surface drainage shall be provided as shown by molding the surfaces to facilitate the natural run-off of water. Low spots and pockets shall be filled with amended topsoil and graded to drain properly.

L. Finish grade for sodded areas shall be 2 inches below finish grade of adjacent pavement. Finish grade (top of bark mulch) shrub bed areas shall be 1 inches below finish grades of adjacent pavement.

3.3 DELIVERY, STORAGE, AND HANDLING OF PLANT MATERIALS

A. No plants other than the required samples shall be dug or delivered to the site until the required inspections have been made and the plant samples are approved

B. Plants shall not be pruned prior to delivery except upon approval by the L.A..

C. Plant material shall be planted on the day of delivery if possible. The CONTRACTOR shall protect the stock in a temporary nursery at the project site where it shall be protected from sun and drying winds and shall be shaded, kept moist, and protected with damp soil, moss, or other acceptable material. Plants shall be planted within 2 days after delivery.

D. All balled and burlapped plants which cannot be planted immediately in delivery shall be set on the ground and shall be well protected with soil, wet moss, or other acceptable material. Bare rooted plants, which cannot be planted immediately, shall be planted on heeled-in trenches immediately upon delivery. No material heeled-in more than one week may be used. Bundles of plants shall be opened and the plants separated before the roots are covered. Care shall be taken to prevent air pockets among the roots.

E. During planting operations, bare roots shall be covered with canvas, wet straw, or other suitable materials. No plants shall be bound with wire or rope at any time so as to damage the bark or break branches.

F. Plants shall not be picked up or moved by stem or branches, but shall be lifted the ball or container.

G. Plants shall be lifted and handled from the bottom of the ball or container. Plants with balls cracked or broken before or during planting operations will not be accepted and shall be immediately removed from the site.

3.4 TREE AND PLANT LOCATIONS

A. The CONTRACTOR shall locate and stake all tree and shrub locations and have the locations approved by the L.A. before starting excavation for same. The plant locations shall be observed, and their locations shall be adjusted as directed by L.A. before final approval.

B. No trees shall be located closer than 72 inches to structures unless otherwise shown. Ground covers and shrubs may be planted up to structures or curbs.

3.5 PLANT PITS

A. Plant pits, centered on location stakes, shall be excavated circular pits with vertical sides and flat or saucer shape bottom in accordance with the following sizes unless shown
   1. Tree pits shall be at least 3 times greater in diameter than the specific diameter of ball or spread of roots, and at depth of ball or roots.
   2. Tree pits shall include drainage sump as indicated on the drawings.
   3. Shrubs shall be planted in pits or holes of soil the depth of ball below finished grade, or as much deeper as necessary to properly set the plant at finished grade.

3.6 PREPARED BACKFILL

A. Tree and shrub pit backfilling soil shall consist of amended topsoil.

B. Tree and shrub pits shall be provided with fertilizer tablets as follows:
   1. 1 per one-gallon can plant
   2. 3 per 5-gallon can plant
   3. 4 per trees

3.7 ROCKS OR UNDERGROUND OBSTRUCTIONS

A. In the event that rock or underground obstructions are encountered in the excavation of plant pits, alternative locations shall be selected by the L.A.. Moving of trees to alternative locations shall not entail additional costs to the OWNER.

3.8 SETTING PLANT MATERIALS

A. The soil shall not be worked when the moisture content is so great that excessive compaction will occur, nor when it is so dry that a dust will form in the air or that clods will not break readily. Water shall be applied if necessary to provide ideal moisture for filling and for planting as herein specified.

B. Plants shall be set in center of pits as shown in the Contract Documents. They shall be set plumb and straight, and at such a level that after settlement that the crown of the plant will be 1 to 2 inches above the finished grade.

C. Balled and burlapped trees shall have planting soil placed and compacted around base of ball to fill all voids. All burlap ropes or wires shall be removed from the sides and tops of balls.

D. All ground cover plants shall be evenly spaced, staggered in rows, and set at intervals specified, so as to produce a uniform effect. Plants shall be watered immediately after planting operations have been completed.

E. All shrubs and vines shall be pruned to remove damaged branches. All bare root shrubs shall be pruned and shaped to compensate for transplant root loss.

F. Planting soil around roots or balls shall be thoroughly compacted and watered. After planting, the soil in the shrub beds shall be cultivated between shrubs, raked smooth, and neatly outlined. Muddy soil shall not be used for backfilling. All broken or frayed roots shall be properly cut off.

G. Trees and shrubs on slopes steeper than 6 to 1 shall be provided with watering dams or berms at least 6 inches high and 8 inches wider than planting pit (hole) unless specified or shown otherwise.

H. All trees shall be thoroughly watered immediately after planting.

I. Remove all tags and labels when directed by L.A..

3.9 STAKING AND TREE WRAPPING

A. Staking of trees shall be done immediately after they are planted. Plants shall stand plumb after staking. Staking shall be as indicated on Drawings.

B. Trees 2-inch caliper and less shall be supported by 2 stakes placed diametrically opposite at perimeter line of ball and to sufficient depth to hold tree rigid. Stakes shall be driven vertically and not twisted or pulled. Trees shall be wired to each stake as indicated on Drawings.

C. All deciduous trees greater than 2-inch caliper and all evergreen trees 6'-0" and taller shall be triple staked or guyed as indicated on Drawings.

3.10 PRUNING AND MULCHING

A. Each tree and shrub shall be pruned in accordance with standard horticultural practice to preserve the natural character of the plant in the manner fitting its use in the landscape design. Prune plant material only as approved by the L.A..

B. All dead wood or suckers and all broken or badly bruised branches shall be removed by thinning out and shortening branches. Deciduous bare-rooted plants shall have not less than 1/3 of their respective leaf surfaces removed. All cuts shall be made just above a healthy bud. Pruning shall be done with clean, sharp tools.

C. Plants shall be mulched after planting and cultivating have been completed. A layer of mulch materials, as hereinbefore specified, shall be spread on finished landscaping grade within all planting areas to depths as indicated on the drawings. The mulch around isolated trees shall be 3 feet in diameter. All shrub and ground cover beds shall be completely covered with the mulch as indicated on the Drawings.

3.11 SODDING

A. Grass sod shall be provided where shown or specified and shall be maintained.

B. The soil shall be prepared and fertilized before sodding. The CONTRACTOR shall prepare only enough ground that can be planted within 24 hours thereafter.

C. Soil preparation shall consist of the following:
   1. Preparation of sub-grade grading shall be per "Part 3 -- Execution" in Paragraphs entitled "General" and "Soil Preparation," herein.

D. Sod shall be cut and laid on site the same day.

E. The sod shall be placed over leveled, compacted, and prepared finish graded soil. The amended topsoil and sub-base shall be moist enough to resist shifting.

F. Sod may be placed at any time when the ground is not frozen. The surface on which the sod is to be laid should be firm and free from footprints or other depressions. A string or line of boards may be used as a guide for setting the first line of sod across the area. Sods of the next

course are matched against the edge of this first line in such a way the joints between the individual sod pieces in the 2 lines do not coincide. Successive courses are matched against the last line laid, in the same manner.

G. Sod shall always be laid across slopes.

H. After sodding has been completed, the sodded area shall be cleaned up and thoroughly moistened by irrigation system.

I. Soil preparation shall consist of the following:
   1. Preparation of sub-grade grading shall be per Paragraphs entitled "General" and "Soil Preparation," respectively, herein.
   2. Finish grading of soil per Paragraph entitled "Soil Preparation", herein.

3.12 MISCELLANEOUS ITEMS

A. Mulch shall be placed in the planting areas as shown, spread carefully and evenly to depths as indicated on the drawings over the entire area. Bark mulch installed in tree rings in turf areas.

B. Place landscape accent boulder in areas as noted on plans. Boulders to be placed to look natural. Refer to detail.

END OF SECTION 32 9300

SECTION 33 1116 - WATER (CULINARY AND FIRE) DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The latest edition of the U of U guidelines and standards shall be followed:

1.2 SUMMARY

A. This Section includes water-distribution piping and specialties outside the building for the following:

1. Water services.
2. Fire-service mains.
3. Combined water service and fire-service mains.

1.3 DEFINITIONS

A. Combined Water Service and Fire-Service Main: Exterior water piping for both domestic-water and fire-suppression piping.

B. Fire-Service Main: Exterior fire-suppression-water piping.

C. Fire-Suppression-Water Piping: Interior fire-suppression-water piping.

D. Water-Distribution Piping: Interior domestic-water piping.

E. Water Service: Exterior domestic-water piping.

F. Secondary water: Exterior irrigation water piping

G. Chilled water: Supply and return mains for exterior chilled water piping.

H. The following are industry abbreviations for plastic materials:

1. PE: Polyethylene plastic.
2. PP: Polypropylene plastic.
3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Piping specialties.
2. Valves and accessories.
3. Backflow preventers and assemblies.
4. Fire hydrants.

B. Field Quality-Control Test Reports: From Contractor.

C. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section “Operation and Maintenance Data" include the following:

1. Valves.
2. Backflow preventers.
3. Fire hydrants.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

D. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:

1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 REFERENCES

1. American Welding Society / American National Standards Institute:

AWWA C110 / ANSI A21.10-2003, 'Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in, for Water and Other Fluids.'

2. American Society For Testing and Materials:
ASTM A 377-99, 'Standard Index of Specifications for Ductile-Iron Pressure Pipe.'

1.7 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

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

1. Notify University not less than three days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without University’s written permission.

1.9 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Gaskets: AWWA C111, rubber.

2.4 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

B. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A), and ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

D. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.5 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D 1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.

B. PVC, Schedule 80 Pipe: ASTM D 1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

C. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket and spigot end.

1. Comply with UL 1285 for fire-service mains if indicated.
2. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

   a. Gaskets: AWWA C111, rubber.

5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

   a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.6 JOINING MATERIALS

A. Refer to Division 2 Section for commonly used joining materials.

B. Transition Couplings:

1. Underground Piping, NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
2. Underground Piping, NPS 2 (DN 50) and Larger: AWWA C219, metal, sleeve-type coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
3. Aboveground or Vault Piping: Pipe fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Brazing Filler Metals: AWS A5.8, BCuP Series.

D. Soldering Flux: ASTM B 813, water-flushable type.

E. Solder Filler Metal: ASTM B 32, lead-free type with 0.20 percent maximum lead content.

2.7 PIPING SPECIALTIES

A. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

B. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.

1. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
2. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
3. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

    a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.

4. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
5. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.8 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Manufacturers:

a. American AVK Co.; Valves & Fittings Div.
b. American Cast Iron Pipe Co.; American Flow Control Div.
c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Grinnell Corporation; Mueller Co.; Water Products Div.
f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
g. McWane, Inc.; Kennedy Valve Div.
h. McWane, Inc.; Tyler Pipe; Utilities Div.

2. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

a. Minimum Working Pressure: 200 psig (1380 kPa).
b. End Connections: Mechanical joint.
c. Interior Coating: Complying with AWWA C550.

3. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves: AWWA C509, ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

a. Minimum Working Pressure: 250 psig (1725 kPa).
b. End Connections: Push-on or mechanical joint.
c. Interior Coating: Complying with AWWA C550.

B. Bronze Gate Valves:

1. Manufacturers :

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Grinnell Corporation.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.

2. Nonrising-Stem Gate Valves: MSS SP-80, Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.

2.9 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies: Comply with MSS SP-60. Include sleeve and valve compatible with drilling machine.

1. Manufacturers:

   a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
   b. East Jordan Iron Works, Inc.
   c. Grinnell Corporation; Mueller Co.; Water Products Div.
   d. International Piping Services Company.
   e. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   f. McWane, Inc.; Kennedy Valve Div.
   g. McWane, Inc.; M & H Valve Company Div.

2. Tapping Sleeve: Cast- or ductile-iron, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
3. Valve: AWWA, cast-iron, nonrising-stem, resilient seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over valve, and approximately 5-inch-(125-mm-) diameter barrel.

   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.10 CHECK VALVES

A. AWWA Check Valves:

   1. Manufacturers:

      a. American AVK Co.; Valves & Fittings Div.
      b. American Cast Iron Pipe Co.; American Flow Control Div.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Crane Co.; Crane Valve Group; Stockham Div.
      e. Grinnell Corporation; Mueller Co.; Water Products Div.
      f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      g. McWane, Inc.; Kennedy Valve Div.
      h. McWane, Inc.; M & H Valve Company Div.
      i. NIBCO INC.
      j. Valve and Primer Corp.
      k. Watts Industries, Inc.; Water Products Div.

   2. Check Valves: AWWA C508, swing-check type with 175-psig (1207-kPa) working-pressure rating and resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
   3. Check Valves: UL 312, swing-check type with 175-psig (1207-kPa) working-pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.
   4. Check Valves: UL 312, swing-check type with 250-psig (1725-kPa) working-pressure rating, rubber-faced checks unless otherwise indicated, and ends matching piping.

2.11 CORPORATION VALVES AND CURB VALVES

A. Manufacturers:

1. Amcast Industrial Corporation; Lee Brass Co.
2. Ford Meter Box Company, Inc. (The).
3. Grinnell Corporation; Mueller Co.; Water Products Div.
4. Jones, James Company.
5. Master Meter, Inc.
6. McDonald, A. Y. Mfg. Co.

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over curb valve, and approximately 3-inch- (75-mm-) diameter barrel.

1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.12 RELIEF VALVES

A. Manufacturers:

1. APCO.
2. BERMAD.
3. GA Industries, Inc.
4. MULTIPLEX Manufacturing Co.
5. OCECO, Inc.
6. Val-Matic Valve & Mfg. Corp.

B. Air/Vacuum Valves: AWWA C512, direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping. Include 300-psig (2070-kPa) working-pressure design.

2.13 FREESTANDING FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants: AWWA C502, one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure, and 150-psig (1035-kPa) minimum working-pressure design.

1. Manufacturers:

   a. American AVK Co.; Valves & Fittings Div.
   b. American Cast Iron Pipe Co.; American Flow Control Div.
   c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
   d. American Foundry Group, Inc.
   e. Grinnell Corporation; Mueller Co.; Water Products Div.
   f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   g. McWane, Inc.; Kennedy Valve Div.
   h. McWane, Inc.; M & H Valve Company Div.

2. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
3. Operating and Cap Nuts: Pentagon, 1-1/2 inches (40 mm) point to flat.
4. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
5. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 331200 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.

C. Do not use flanges, unions, or keyed couplings for underground piping.

D. Flanges, unions, keyed couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground Water-Service Piping and Vault: Use any of the following piping materials for each size range:

1. NPS 3/4 to NPS 2 (DN 20 to DN 50): Soft copper tube, Type K (Type A) or Type L; wrought-copper fittings; and soldered joints.
2. NPS 3/4 to NPS 2 (DN 20 to DN 50): PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
4. NPS 4 to NPS-12: Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed or mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
5. NPS 4 (DN 100): PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated or molded fittings; and gasketed joints.

F. Underground Combined Water-Service and Fire-Service-Main Piping: Use the following:

1. NPS 6 to NPS 12 (DN 150 to DN 300): Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed or mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
2. NPS 6 to NPS 12 (DN 150 to DN 300): PVC, AWWA Class 150 pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.

G. Underground Combined Water-Service and Fire-Service main Piping: Ductile-iron pipe with grooved ends; ductile-iron, grooved-end fittings; ductile-iron keyed couplings; and grooved joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
2. Use the following for valves in vaults and aboveground:

   a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, rising stem.
   b. Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, rising stem, resilient seated.
   c. Check Valves: AWWA C508, swing-check valves.

3. Water-Regulating Valves: Use for water-service piping in vaults and aboveground.

   a. Pressure-Regulating Valves: To control water pressure.

b. Flow-Regulating Valves: To control water flow.

3.4 JOINT CONSTRUCTION

A. Make pipe joints according to the following:

1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
3. Copper Tubing Soldered Joints: ASTM B 828. Use flushable flux and lead-free solder.
4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
5. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

F. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

G. Install PVC, AWWA pipe according to AWWA M23 and ASTM F 645.

H. Bury piping with depth of cover over top at least 60 inches (1500 mm), with top at least 12 inches (300 mm) below level of maximum frost penetration.

I. Install piping by tunneling, jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

J. Extend water-service piping and connect to water-supply source and building water piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water piping systems when those systems are installed.

K. Sleeves are specified in Division 22 &23 Section "Basic Mechanical Materials and Methods."

L. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

M. Anchor service-entry piping to building wall.

3.6 ANCHORAGE INSTALLATION

A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Fire-Service-Main Piping: According to NFPA 24.

B. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.8 VAULT CONSTRUCTION and INSTALLATION

A. See Division 3 Section "Cast-in-Place Concrete" for concrete vaults.

B. Install precast concrete vaults according to ASTM C 891.

3.9 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. UL/FM-Type Fire Hydrants: Comply with NFPA 24.

3.10 CONNECTIONS

A. Connect water-distribution piping to existing water main. Use tapping sleeve and tapping valve.

B. Connect water-distribution piping to interior domestic-water and fire-suppression piping.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests (this is for all piping). Test at not less than 200 psi or 1-1/2 times working pressure for 2 hours.

1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.12 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. See Division 331200 Section "Earthwork" for underground warning tapes.

B. Permanently attach equipment nameplate or marker, indicating plastic water-service piping, on main electrical meter panel.

3.13 CLEANING (for culinary, and fire service main piping).

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below:

   a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
   b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
   c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 1116

SECTION 33 1200 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns, and plantings.
2. Excavating for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches within building lines.
8. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.3 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Layer placed between the subbase course and asphalt paving.

C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

F. Engineered and Structural Fill: Fill material use to raise grade under building and under structures.

G. Excavation: Removal of material encountered above subgrade elevations.

1. Additional Excavation: Excavation below subgrade elevations as directed by Architect.
2. Bulk Excavation: Excavations more than 10 feet (3 m) in width and pits more than 30 feet (9 m) in either length or width.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

H. Fill: Soil materials used to raise existing grades.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.

K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

L. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 1557 for each on-site or borrow soil material proposed for fill and backfill.

1.5 QUALITY ASSURANCE

A. No blasting allowed.

B. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials testing, as documented according to ASTM D 3740 and ASTM E 548.

D. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify University not less than five days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without University's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 12 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Satisfactory soil materials.

E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2- inch (38-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

F. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (38-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

G. Engineered/Structural Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with a maximum particle size of 4-inches, at least 90 percent passing a 1-1/2-inch (38-mm) sieve and not more than 10 percent passing a No. 200 (0.075-mm) sieve. The liquid limit of fines shall not exceed 35 and the plasticity index should be below 15.

H. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

I. Drainage Course: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 EXPLOSIVES

1. No explosives allowed.

3.3 EXCAVATION, GENERAL

A. Classified Excavation: Excavation to subgrade elevations classified as earth and rock.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock.

    a. Included in scope of work without change order.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended for bearing surface.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: 12 inches (300 mm) on each side of pipe or conduit.
2. Clearance: As indicated.

C. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 APPROVAL OF SUBGRADE

A. Notify Soils Testing Agency when excavations have reached required subgrade.

B. If Soils Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted engineered fill material as directed.

C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.11 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings; fill with concrete to elevation of bottom of footings.

C. Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase.

D. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.

   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

E. Coordinate backfilling with utilities testing.

F. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

G. Place and compact final backfill of satisfactory soil material to final subgrade.

H. Install warning tape directly above utilities, 12 inches (300 mm) above utility.

3.12 FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations as follows:

   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use subbase course material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

3.13 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill material at 95 percent. Fills greater than 6 feet deep to be compacted to 98 percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 95 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 90 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.16 SUBBASE AND BASE COURSES

A. Under pavements and walks, place subbase course on prepared subgrade and as follows:

1. Place base course material over subbase.
2. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
3. Shape subbase and base to required crown elevations and cross-slope grades.
4. When thickness of compacted subbase or base course is 6 inches (150 mm) or less, place materials in a single layer.
5. When thickness of compacted subbase or base course exceeds 6 inches (150 mm), place materials in equal layers, with no layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick when compacted.

B. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet (30 m) or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet (46 m) or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

   1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 33 1200

SECTION 33 3313 - SANITARY SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes sanitary sewerage outside the building.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for concrete structures.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene-monomer rubber.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 SUBMITTALS

A. Shop Drawings: Include plans, elevations, details, and attachments for the following:

1. Precast concrete manholes, including frames and covers.
2. Cast-in-place concrete manholes and other structures, including frames and covers.

B. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify University not less than three days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without University's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1. Gray-Iron Cleanouts:

a. Josam Co.
b. McWane, Inc.; Tyler Pipe; Wade Div.
c. Smith: Jay R. Smith Mfg. Co.
d. Watts Industries, Inc.; Ancon Drain Div.
e. Watts Industries, Inc.; Enpoco, Inc. Div.
f. Zurn Industries, Inc.; Hydromechanics Div.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 PIPES AND FITTINGS

A. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: ASTM A 74, gray iron, for gasketed joints.

1. Gaskets: ASTM C 564, rubber, compression type, thickness to match class of pipe.

B. Ductile-Iron Sewer Pipe: ASTM A 746, for push-on joints.

1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
2. Gaskets: AWWA C111, rubber.

C. Stainless-Steel Drainage Pipe and Fittings: ASME A112.3.1; ASTM A 666, Type 304, stainless steel; with socket and spigot ends for gasketed joints.

D. ABS Sewer Pipe and Fittings: ASTM D 2751, for solvent-cemented or gasketed joints.

1. Wall Thickness for NPS 3 to NPS 6 (DN80 to DN150): SDR 35.
2. Wall Thickness for NPS 8 to NPS 12 (DN200 to DN300): SDR 42.
3. Gaskets: ASTM F 477, elastomeric seals.

E. PVC Sewer Pipe and Fittings: According to the following:

1. PVC Sewer Pipe and Fittings, NPS 15 (DN375) and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.

a. Gaskets: ASTM F 477, elastomeric seals.

F. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M), Class III, Wall B, for gasketed joints.

1. Gaskets: ASTM C 443 (ASTM C 443M), rubber.

2.4 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.

1. Sleeve Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.
2. Sleeve Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
3. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
4. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
5. Bands: Stainless steel, at least one at each pipe insert.

B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.

1. Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.

2. Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
3. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
4. Material for Dissimilar Pipe: Compatible with pipe materials being joined.

2.5 MANHOLES

A. Normal-Traffic Precast Concrete Manholes: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.

1. Diameter: 60 inches minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 4-inch (100-mm) minimum thickness, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and cover.
8. Steps: Fiberglass, individual steps or ladder. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12-inch intervals. Omit steps for manholes less than 60 inches (1500 mm) deep.
9. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (178- to 229-mm) riser with 4-inch (100-mm) minimum width flange, and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering "SANITARY SEWER" cast into cover.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 400), deformed steel.

C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

    a. Invert Slope: 2 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

    a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water-cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 400), deformed steel.

2.7 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications according to the following applications:

1. Light Duty: In earth or grass foot-traffic areas.
2. Medium Duty: In paved foot-traffic areas.
3. Heavy Duty: In vehicle-traffic service areas.
4. Extra-Heavy Duty: In roads.
5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 33 Section "Earthwork."

3.2 IDENTIFICATION

A. Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

A. General: Include watertight joints.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

C. Gravity-Flow Piping: Use the following:

1. Hub-and-spigot, Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Ductile-iron sewer pipe; standard-pattern, ductile-iron fittings; gaskets; and gasketed joints.
3. ABS, SDR 35, sewer pipe and fittings; solvent-cemented joints; or gaskets and gasketed joints.

3.4 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for nonpressure applications:

a. Sleeve type to join piping, of same size, or with small difference in OD.
b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
c. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.5 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

1. Install piping pitched down in direction of flow, at minimum slope of 2 percent, unless otherwise indicated.
2. Install piping with 36-inch (1000-mm) minimum cover.

F. Extend sanitary sewerage piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

3.6 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: With rubber gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook." Use gaskets that match class of pipe and fittings.

C. Hubless Cast-Iron Soil Pipe and Fittings: With heavy-duty-type couplings according to CISPI 310, CISPI's "Cast Iron Soil Pipe and Fittings Handbook," and coupling manufacturer's written instructions.

D. Ductile-Iron Sewer Pipe with Ductile-Iron Fittings: According to AWWA C600.

E. PVC Sewer Pipe and Fittings: As follows:

1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
2. Join profile sewer pipe fittings with gaskets according to ASTM D 2321 and manufacturer's written instructions.
3. Install according to ASTM D 2321.

F. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual." Use the following seals:

1. Round Pipe and Fittings: ASTM C 443 (ASTM C 443M), rubber gaskets.

G. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

H. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

I. Install with top surfaces of components, except piping, flush with finished surface.

3.7 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Form continuous concrete channels and benches between inlets and outlet.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere, unless otherwise indicated.

D. Install precast concrete manhole sections with gaskets according to ASTM C 891.

E. Construct cast-in-place manholes as indicated.

F. Provide connection boots for precast concrete manholes.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.9 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.10 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.

B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

C. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN100 to DN500). Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

D. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.11 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- (200-mm-) thick, concrete masonry bulkheads.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:

1. Remove structure and close open ends of remaining piping.
2. Remove top of structure down to at least 36 inches (1000 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
3. Backfill to grade according to Division 33 Section "Earthwork."

3.12 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.

1. Place plug in end of incomplete piping at end of day and when work stops.
2. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.

5. If authorities having jurisdiction do not have published procedures, perform tests as follows:

    a. Sanitary Sewerage: Perform hydrostatic test.

        1) Allowable leakage is maximum of 50 gal. per inch of nominal pipe size per mile (4.6 L per millimeter of nominal pipe size per kilometer) of pipe, during 24-hour period.
        2) Close openings in system and fill with water.
        3) Purge air and refill with water.
        4) Disconnect water supply.
        5) Test and inspect joints for leaks.
        6) Option: Test ductile-iron piping according to AWWA C600, Section "Hydrostatic Testing." Use test pressure of at least 10 psig (69 kPa).

    b. Sanitary Sewerage: Perform air test according to UNI-B-6.

        1) Option: Test concrete piping according to ASTM C 924).

6. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
7. Leaks and loss in test pressure constitute defects that must be repaired.
8. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 33 3313

SECTION 33 4100 - STORM DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes storm drainage outside the building.

B. Related Sections include the following:

1. Division 03 Section, “Cast-in-Place Concrete” for concrete structures.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene-monomer rubber.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Stormwater disposal systems.

B. Shop Drawings: Include plans, elevations, details, and attachments for the following:

1. Precast concrete manholes and other structures, including frames, covers, and grates.
2. Cast-in-place concrete manholes and other structures, including frames, covers, and grates.

C. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify University not less than three days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without University’s written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Stormwater Disposal Systems:

1) Advanced Drainage Systems, Inc.
2) Cultec, Inc.
3) Hancor, Inc.
4) Infiltrator Systems, Inc.
5) PSA, Inc.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 PIPES AND FITTINGS

A. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: ASTM A 74, gray iron, for gasketed joints.

1. Gaskets: ASTM C 564, rubber, compression type, thickness to match class of pipe.

B. Ductile-Iron Sewer Pipe: ASTM A 746, for push-on joints.

1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
2. Gaskets: AWWA C111, rubber.

C. Ductile-Iron Culvert Pipe: ASTM A 716, for push-on joints.

1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
2. Gaskets: AWWA C111, rubber.

D. Corrugated PE Drainage Tubing and Fittings: AASHTO M 252, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 252, corrugated, matching tube and fittings to form soiltight joints.
2. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings to form silttight joints.

E. Corrugated PE Pipe and Fittings: AASHTO M 294, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings to form soiltight joints.
2. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings to form silttight joints.

F. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M), Class III, Wall B, for gasketed joints.

1. Gaskets: ASTM C 443 (ASTM C 443M), rubber.

2.4 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.

1. Sleeve Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.
2. Sleeve Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
3. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
4. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
5. Bands: Stainless steel, at least one at each pipe insert.

B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.

1. Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.
2. Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
3. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
4. Material for Dissimilar Pipe: Compatible with pipe materials being joined.

2.5 MANHOLES

A. Normal-Traffic Precast Concrete Manholes: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.

1. Diameter: 60 inches (1200 mm) minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 4-inch (100-mm) minimum thickness, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and cover.
8. Steps: Fiberglass, individual steps. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch (300- to 400-mm) intervals. Omit steps for manholes less than 60 inches (1500 mm) deep.
9. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (178- to 229-mm) riser with 4-inch (100-mm) minimum width flange, and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering "STORM SEWER" cast into cover.

2.6 CATCH BASINS

A. Normal-Traffic, Precast Concrete Catch Basins: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.

1. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
2. Riser Sections: 4-inch (100-mm) minimum thickness, 48-inch (1220-mm) diameter, and lengths to provide depth indicated.
3. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

4. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
5. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.
6. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

B. Cast-in-Place Concrete, Catch Basins: Construct of reinforced concrete; designed according to ASTM C 890 for structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Bottom, Walls, and Top: Reinforced concrete.
2. Channels and Benches: Concrete.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (178- to 229-mm) riser with 4-inch (100-mm) minimum width flange, and 26-inch- (660-mm-) diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.7 STORMWATER INLETS

A. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

B. Frames and Grates: Heavy-duty frames and grates according to utility standards.

C. Combination Inlets: Vertical curb and horizontal gutter openings, of materials and dimensions indicated. Include heavy-duty frames and grates.

D. Frames and Grates: Dimensions, opening pattern, free area, and other attributes indicated.

1. Material: ASTM A 48, Class 30 (ASTM A 48M, Class No. 200A) minimum, gray-iron casting.
2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious ratio.

1. Include channels and benches in manholes.

1) Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

2) Invert Slope: 2 percent through manhole.
3) Invert Slope: None.

4) Benches: Concrete, sloped to drain into channel.

5) Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

2.9 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications according to the following applications:

1. Light Duty: In earth or grass foot-traffic areas.
2. Medium Duty: In paved foot-traffic areas.
3. Heavy Duty: In vehicle-traffic service areas.
4. Extra-Heavy Duty: In roads.
5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.10 DRAINS

A. Gray-Iron Area Drains: ASME A112.21.1M, round, gray-iron body with anchor flange and round, secured, gray-iron grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated. Use units with top-loading classifications according to the following applications:

1. Medium Duty: In paved foot-traffic areas.
2. Heavy Duty: In vehicle-traffic service areas.

B. Gray-Iron Trench Drains: ASME A112.21.1M, 6-inch- (150-mm-) wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular, secured grate. Include units of total lengths indicated and number of bottom outlets with inside calk or spigot connections, of sizes indicated. Use units with top-loading classifications according to the following applications:

1. Medium Duty: In paved foot-traffic areas.
2. Heavy Duty: In vehicle-traffic service areas.
3. Extra-Heavy Duty: In roads.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 33 Section "Earthwork."

3.2 IDENTIFICATION

A. Materials and their installation are specified in Division 33 Section "Earthwork." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

A. General: Include watertight, silttight, or soiltight joints, unless watertight or silttight joints are indicated.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

C. Gravity-Flow Piping: Use the following:

1. Hub-and-spigot, Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. ABS, SDR 35, sewer pipe and fittings; solvent-cemented joints; or gaskets and gasketed joints.
3. Corrugated PE drainage tubing and fittings, soiltight couplings, and coupled joints.

3.4 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for nonpressure applications:

A. Sleeve type to join piping, of same size, or with small difference in OD.
B. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
C. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.5 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install piping with 24-inch minimum cover.

F. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

3.6 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: With rubber gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook." Use gaskets that match class of pipe and fittings.

C. Ductile-Iron Sewer Pipe with Ductile-Iron Fittings: According to AWWA C600.

D. Install with top surfaces of components, except piping, flush with finished surface.

E. PE Pipe and Fittings: As follows:

1. Join pipe, tubing, and fittings with couplings for soiltight joints according to manufacturer's written instructions.
2. Install according to ASTM D 2321 and manufacturer's written instructions.
3. Install corrugated piping according to the Corrugated Polyethylene Pipe Association's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

F. PVC Sewer Pipe and Fittings: As follows:

1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
2. Install according to ASTM D 2321.

G. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual." Use the following seals:

1. Round Pipe and Fittings: ASTM C 443 (ASTM C 443M), rubber gaskets.

H. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

I. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.7 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere, unless otherwise indicated.

C. Install precast concrete manhole sections with gaskets according to ASTM C 891.

D. Construct cast-in-place manholes as indicated.

3.8 CATCH-BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.9 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.10 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.11 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

B. Embed drains in 4-inch (100-mm) minimum depth of concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

3.12 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.

B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

C. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN100 to DN500). Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

D. Make branch connections from side into existing piping, NPS 21 (DN525) or larger, or to underground structures by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

    1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi (20.7 MPa), unless otherwise indicated.
    2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

E. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.13 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- (200-mm-) thick, brick masonry bulkheads or concrete.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:

1. Remove structure and close open ends of remaining piping.
2. Remove top of structure down to at least 36 inches (1000 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
3. Backfill to grade according to Division 33 Section "Earthwork."

3.14 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and when work stops.
3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:

A. Alignment: Less than full diameter of inside of pipe is visible between structures.
B. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
C. Crushed, broken, cracked, or otherwise damaged piping.
D. Infiltration: Water leakage into piping.
E. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.

3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.
5. Where authorities having jurisdiction do not have published procedures, perform tests as follows:
6. Leaks and loss in test pressure constitute defects that must be repaired.
7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 33 4100

APPENDIX – DOCUMENT 01

1.1 GEOTECHNICAL DATA

A. This Document (attached at the end of this Project manual) with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.

B. A geotechnical investigation report, (Y^2 job number 12G-019) for Project, prepared by Y^2 Geotechnical, P.C., dated April 24, 2012, is available for viewing as appended at the end of this this Project Manual.

END OF DOCUMENT

Y2 Geotechnical, P.C.
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GEOTECHNICAL STUDY
THE ICE SHEET - ADDITION
4390 HARRISON BLVD.
OGDEN, UTAH

Prepared By:

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Y² JOB NUMBER: 12G-019

Prepared for:

TODD FERRARIO
WEBER COUNTY ICE SHEET
4390 HARRISON BLVD.

April 24, 2012

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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed building addition at the Weber County Ice Sheet located at 4390 Harrison Blvd. in Ogden, Utah. The general location of the site, with respect to existing roadways, is shown on Figure No. 1, *Vicinity Map*, at the end of this report.

This investigation was done to assist in evaluating the subsurface conditions and engineering characteristics of the foundation soils and in developing our opinions and recommendations concerning appropriate foundation types and floor slabs. This report presents the results of our geotechnical investigation including field exploration, laboratory testing, engineering analysis, and our opinions and recommendations. Data from the study is summarized on Figures 3 thru 6, and in the Laboratory Results.

2.0 PROPOSED CONSTRUCTION

We understand that the proposed project will consist of an addition to the existing sheet facility. The proposed building is expected to be a multi-story structure with a basement approximately 310 by 225 feet in size. We estimate that the maximum loads for the proposed structures will not exceed 8 kips per linear foot for bearing walls, 150 kips for columns, and 150 to 200 pounds per square foot for floor slabs.

It is anticipated that utilities may be constructed to service the building and that exterior concrete flatwork may be placed in the form of curb and gutter, and sidewalks.

If structural loads are significantly greater than those discussed herein or if the project is substantially different than described above, our office should be notified so that we may review our recommendations, and if necessary, make modifications.

3.0 CONCLUSIONS

The following is a brief summary of our findings and conclusions:

1. The subject site is suitable for the proposed construction provided the recommendations presented in this report are followed.

2. Based upon the 4 boreholes drilled for this investigation, this site is covered with 3 to 5 inches of asphalt and approximately 12 inches of road base. Up to 25 inches of mixed sand and clay fill was encountered below the road base. The native soil below the pavement section and fill consisted of loose to very dense poorly graded sand with silt (SP-SM) and silty sand (SM) which extended to the maximum depth investigated (16½ ft). Water was not encountered in our boreholes at the time of the investigation.

3. Conventional strip and spread footings are recommended for support of the proposed buildings. Footings founded on the native soils or properly placed, compacted and tested structural fill extending to the undisturbed native soils may be designed for a maximum allowable soil bearing capacity of 2,400 psf. Additional information on footing design is given in Section 10.0 in this report.

4.0 SITE CONDITIONS

The project area is currently developed as a parking lot adjacent to the existing building. The proposed building is located south and west of the existing building. The majority of the project area is relatively level with a 2 to 4 percent grade downward to the west. The western edge of the project area slopes off steeply downward at roughly 25 percent. The project area is mostly covered with asphalt pavement and concrete flat-work. There are some areas of landscaped lawn and planting beds. The project area site is bound to the north by the existing building, to the south and east by parking lot, and to the west by the slope and then an apartment complex. No surface water sources were observed on the site during our investigation.

5.0 FIELD INVESTIGATION

The field investigation consisted of drilling 4 boreholes to depths of 11½ tp 16½ feet below current site grades at the approximate locations shown on Figure 2, at the end of this report. The soils

encountered at the site were continuously logged by a professional engineer from our office. Due to the granular nature of the soils only disturbed samples were obtained and returned to our laboratory for testing.

6.0 LABORATORY TESTING

The samples obtained during the field investigation were sealed and returned to our laboratory where samples were selected for laboratory testing. Laboratory tests included natural moisture determinations and grain size distribution analyses. The results of these tests are shown at the end of this report.

Samples will be retained in our laboratory for 30 days following the date of this report at which time they will be disposed of unless a written request for additional holding time is received prior to the disposal date.

7.0 SUBSURFACE CONDITIONS

Based upon the 4 boreholes drilled for this investigation, this site is covered with 3 to 5 inches of asphalt and approximately 12 inches of road base. Up to 25 inches of mixed sand and clay fill was encountered below the road base. The native soil below the pavement section and fill consisted of loose to very dense poorly graded sand with silt (SP-SM) and silty sand (SM) which extended to the maximum depth investigated (16½ ft). Water was not encountered in our boreholes at the time of the investigation.

Graphical representations of the soil conditions encountered are shown on the Borehole Logs, Figure 3 thru 6. The stratification lines shown on the Borehole Log represent the approximate boundaries between soil units; the actual transition may be gradual.

8.0 SITE GRADING

8.1 General Site Grading

Prior to construction unsuitable soils and vegetation should be removed from below areas which will ultimately support structural loads. This includes areas below foundations, floor slabs, and concrete flatwork. Unsuitable soils consist of topsoil, organic soils, undocumented fill, soft, loose or disturbed native soils, material associated with demolition of the existing building, and any other deleterious materials. Up to 3½ feet of sandy fill was encountered in our boreholes. All topsoil, uncontrolled fill, or other unsuitable soils should be completely removed.

8.2 Excavations

Due to the nature of the soils at this site, we recommend that temporary construction slopes for excavations into the native soils and onsite fill, less than five feet in depth, not be made steeper than ½ :1 (horizontal:vertical). Excavations deeper than 5 feet should be sloped at 1:1 or be shored prior to anyone entering the excavation. If unstable conditions or groundwater seepage are encountered, flatter slopes or shoring and bracing may be required. All excavations should meet applicable OSHA[1] Health and Safety Standards for type C soils.

8.3 Structural Fill

All fill placed below the structure should be compacted structural fill. All other fills should be considered as backfill. All structural fill should meet the requirements of the agency under which approval will be granted. Unless more restrictive criteria are given, structural fill may consist of the native sand soils or imported structural fill. Imported structural fill material should consist of well-graded sandy gravels to silty sands with a maximum particle size of 4 inches and 5 to 20 percent fines (materials passing the No. 200 sieve). The liquid limit of the fines should not exceed 35 and the plasticity index should be below 15. Clean gravel ranging from pea gravel to 6 inches with less

[1] Occupational Safety and Health Administration

than 5 percent fines and sand combined may also be used as structural fill. All fill soils should be free from topsoils, highly organic material, frozen soil, and other deleterious materials.

8.4 Backfill

The native soils may be used as backfill in utility trenches and against outside foundation walls as long as they are properly moisture conditioned, placed, and compacted. Backfill, not under structural elements, should be placed in lift heights suitable to the compaction equipment used and compacted to at least 90 percent of the maximum dry density (ASTM D-1557).

8.5 Fill Placement and Compaction

The thickness of each lift should be appropriate for the compaction equipment that is used. We recommend a maximum lift thickness of 6 inches for hand operated equipment, 8 inches for most "trench compactors", and 12 inches for larger rollers, unless it can be demonstrated by in-place density tests that the required compaction can be obtained throughout a thicker lift. The full thickness of each lift of structural fill placed should be compacted to at least the percentages of the maximum dry density, shown in Table 1 below, as determined by ASTM D-1557:

TABLE 1: STRUCTURAL FILL COMPACTION

Structural fill	Percent of Maximum Dry Density
Below foundations, flatwork, and pavements:	95%
For fills thicker than 6 feet:	98%
In landscape areas not supporting structural loads:	90%

Generally, placing and compacting fill at a moisture content within 2% of the optimum moisture content, as determined by ASTM D-1557, will facilitate compaction. The further the moisture

content is from the optimum, the more difficult it will generally be to achieve the required compaction.

Clean gravel fill used as structural fill may be placed in loose lifts up to 2 feet thick. The gravel will need to be compacted with at least 4 passes of a vibratory plate or slow moving vibratory smooth drum compactor. Typically, the gravel will settle 1 to 3 inches per foot when properly compacted. Gravel compaction should be verified by either an engineer from Y^2 Geotechnical, P.C. or a materials testing technician from Intermountain Testing Inc., trained in proper gravel placement techniques.

We recommend that fill be tested frequently during placement by a qualified materials testing technician from Intermountain Testing Inc. Early testing is recommended to demonstrate that placement and compaction methods are achieving the required compaction for the entire depth of fill. It is the contractor's responsibility to ensure that fill materials and compaction efforts are consistent so that tested areas are representative of the entire fill.

9.0 SEISMIC CONSIDERATIONS

9.1 Faulting

Based on published data, no active faults are known to traverse the site and no faulting was indicated during our field investigation. The nearest known active fault is the Wasatch Fault, located about ½ mile east of the property[2].

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[2] Black, B.D., DuRoss, C.B., Hylland, M.D., McDonald, G.N., and Hecker, S., compilers, 2004, Fault number 2351e, Wasatch fault zone, Weber section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/regional/qfaults

9.2 Seismic Design Criteria

The structures should be designed in accordance with the IBC building codes. According to section 1613.5.2 of the IBC, this site is classified as a Site Class D.

9.3 Liquefaction

Liquefaction is a phenomenon where soils lose their intergranular strength due to an increase of pore pressures during a dynamic event such as an earthquake. The potential for liquefaction is based on several factors, including 1) the grain size distribution of the soil, 2) the plasticity of the fine fraction of the soil (material passing the No. 200 sieve), 3) relative density of the soil, 4) earthquake strength (magnitude) and duration, and 5) overburden pressures. In addition, the soils must be near saturation for liquefaction to occur. According to the Weber County liquefaction map[3], this site is in an area classified as having low potential for liquefaction.

10.0 FOUNDATIONS

10.1 Footing Design

The native soils at this site are capable of supporting the proposed structures if the recommendations presented in this report are followed. The recommendations presented below should be utilized during design and construction of this project:

1. Conventional strip and spread footings are recommended for support of the proposed building. Footings founded on the native soils or properly placed, compacted and tested structural fill extending to the undisturbed native soils may be designed for a maximum allowable soil bearing capacity of 2,400 psf. A one-third increase is allowed for short term transient loads such as wind and seismic events. Footings should be uniformly loaded.

2. Continuous and spot footings should have minimum widths of 18 and 30 inches, respectively.

---

3 Utah Geologic Survey, Selected Critical Facilities and Geologic Hazards, Weber County, Utah

3. Exterior footings should be placed below frost depth which is determined by local building codes. Generally 30 inches is adequate in this area. Interior footings, not subject to frost, should extend at least 18 inches below the lowest adjacent final grade.

4. Foundation walls on continuous footings should be well reinforced both top and bottom. We suggest a minimum amount of steel equivalent to that required for a simply supported span of 12 feet.

5. Footing excavations should be observed by a geotechnical engineer from Y^2 Geotechnical prior to placement of structural fill and construction of footings to evaluate whether suitable bearing soils have been exposed and verify that excavation bottoms are free of fill, loose, or disturbed soils.

10.2 Estimated Settlement

If footings are designed and constructed in accordance with the recommendations presented above, the risk of total settlement exceeding 1 inch and differential settlement exceeding 0.5 inch for a 25-foot span will be low. Additional settlement may be expected during a strong seismic event.

11.0 LATERAL EARTH PRESSURES

Resistance to lateral loads (including those due to wind or seismic loads) on foundations may be achieved by frictional resistance between the foundations and underlying soils, and by passive earth pressures of backfill soils placed against the sides of foundations. Retaining walls and below grade walls act as soil retaining structures and should be designed to resist pressures induced by the backfill soils.

The lateral pressures imposed on a retaining structure are dependant on the rigidity of the structure and its ability to resist rotation. Retaining walls which are free to rotate at least 0.2 percent of the wall height, develop an active lateral soil pressure condition. Structures that are not allowed to rotate or move laterally, develop an at-rest lateral earth pressure condition. Lateral pressures applied to

structures may be computed by multiplying the vertical depth of backfill material by the appropriate equivalent fluid density. Any surcharge loads in excess of the soil weight applied to the backfill should be multiplied by the appropriate lateral pressure coefficient and added to the soil pressure. The lateral pressures presented in Table 2, *Lateral Earth Pressures* below, are based on drained, horizontally placed soils as backfill material. For computing lateral forces we recommend the following equivalent fluid densities:

TABLE 2: LATERAL EARTH PRESSURES

Condition	Static Lateral Pressure Coefficient	Static Equivalent Fluid Pressure (pcf)	Seismic Equivalent Fluid Pressure (pcf)
Active	0.31	37	60
At-Rest	0.47	56	79
Passive	3.25	391	368

The friction acting along the base of foundations may be computed by using a coefficient of friction of 0.45 for contact with native sand soils. The values presented above are based on drained conditions and are ultimate, therefore, an appropriate factor of safety should be applied to these values for design purposes.

12.0 FLOOR SLABS

The native soils below floor slabs should be proof rolled and a minimum 4 inch thick layer of free-draining gravel or imported structural fill should be placed immediately below the floor slab to help distribute floor loads, break the rise of capillary water, and aid in the concrete curing process. For slab design, we recommend a modulus of subgrade reaction of 200 psi/in be used. Floor slabs should be evaluated by a structural engineer to determine what measures are appropriate to control shrinkage and stress cracking and provide desired support.

Special precautions should be taken during placement and curing of concrete slabs and flatwork. Excessive slump (high water-cement ratios) of the concrete and/or improper finishing and curing procedures used during hot or cold weather conditions may lead to excessive shrinkage, cracking, spalling, or curling of slabs. We recommend all concrete placement and curing operations be performed in accordance with American Concrete Institute (ACI) codes and practices.

13.0 SURFACE DRAINAGE

Wetting of the foundation soils may cause some degree of volume change within the soil should be prevented after construction. We recommend that the following precautions be taken at this site:

1. The ground surface should be graded to drain away from the structures in all directions. We recommend a minimum fall of 6 inches in the first 10 feet for landscaped areas and 1 inch in the first 20 feet for paved surfaces.

2. Roof runoff should be collected in rain gutters with down spouts designed to discharge well outside of the backfill limits.

3. Sprinkler heads, should be aimed away and kept at least 12 inches from foundation walls.

4. Provide adequate compaction of foundation backfill i.e. a minimum of 90% of ASTM D-1557. Water consolidation methods should not be used.

5. Other precautions which may become evident during design and construction should be taken.

14.0 GENERAL CONDITIONS

The exploratory data presented in this report was collected to provide geotechnical design recommendations for this project only and is not intended for application to other sites or projects. Borehole conditions may not be indicative of subsurface conditions outside the study area and thus have limited value in depicting subsurface conditions for contractor bidding. If it is necessary to define subsurface conditions in sufficient detail to allow accurate bidding we recommend an

additional study be conducted which is designed for that purpose. An experienced geotechnical engineer or technician should observe fill placement and conduct testing as required to confirm the use of proper structural fill materials and placement procedures.

Variations from the conditions portrayed in the boreholes may occur and can only be confirmed during earthwork and foundation construction. The topsoil and fill condition indicated in this report represent what was encountered during the site investigation. Subsequent changes to the site may result in fill or topsoil amounts varying from what is represented in this report. If fill, topsoil, or subsurface conditions are found to be different than those presented in this report, we should be notified immediately to determine if changes in the recommendations are required. If Y^2 Geotechnical, P.C., is not contacted about variations in the soil conditions, we cannot be responsible for the impact of those conditions on the performance of the project.

It should be remembered that geotechnical engineering conclusions and recommendations are generated through analytical methods which are not an exact science. Conclusions and recommendations presented in a geotechnical engineering report are not based only on the analytical empirical tools generally used but rely on engineering judgment in conjunction with the tools. The fact that professional judgments must be used in making recommendations means that the conclusions, solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The conclusions and recommendations presented in this report represent the Y^2 Geotechnical, P.C. professional findings regarding the proposed structures and pavements on this project based on the information generated and referenced during this evaluation and Y^2 Geotechnical, P.C.'s experience in working with these conditions.

The geotechnical investigation as presented in this report was conducted within the limits prescribed by our client. The finding and recommendations which have been presented in this report have been

made in accordance with generally accepted professional geotechnical engineering practice in the area at the time of report preparation. Standards of practice are subject to change with time. No other warranty or representation, either expressed or implied is intended in our proposals, contracts or report.

This geotechnical report has been prepared for Weber County for use in the design and construction of the Weber County Ice Sheet Addition project. This report is site specific and should not be relied upon for use in other investigations and is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance and express written consent of the Weber County and Y^2 Geotechnical, P.C.; therefore, any use or reliance upon this geotechnical evaluation by a party other than the Client shall be solely at the risk of such third party and without legal recourse against Y^2 Geotechnical, P.C., its employees, officers, or directors, regardless of whether the action in which recovery of damages is brought is based upon contract, tort, statue, or otherwise. The client has the responsibility to see that all parties to the project including the designer, contractor, subcontractor, and building official, etc., are aware of the geotechnical report in its complete form. Y^2 Geotechnical, P.C., assumes no responsibility or liability for work or testing performed by others.

We appreciate the opportunity of providing our services on this project. If we can answer questions or be of further service, please call.

Respectfully;
Y^2 GEOTECHNICAL, P.C.
Not Official Unless Stamped and dated.

Lori S. Yahne, P.E.
Principal Geotechnical Engineer

Reviewed by,

R. Jay Yahne, P.E.
Principal Geotechnical Engineer

3 copies sent

Y² Geotechnical, P.C.
Geotechnical, Geologic, & Environmental

NORTH

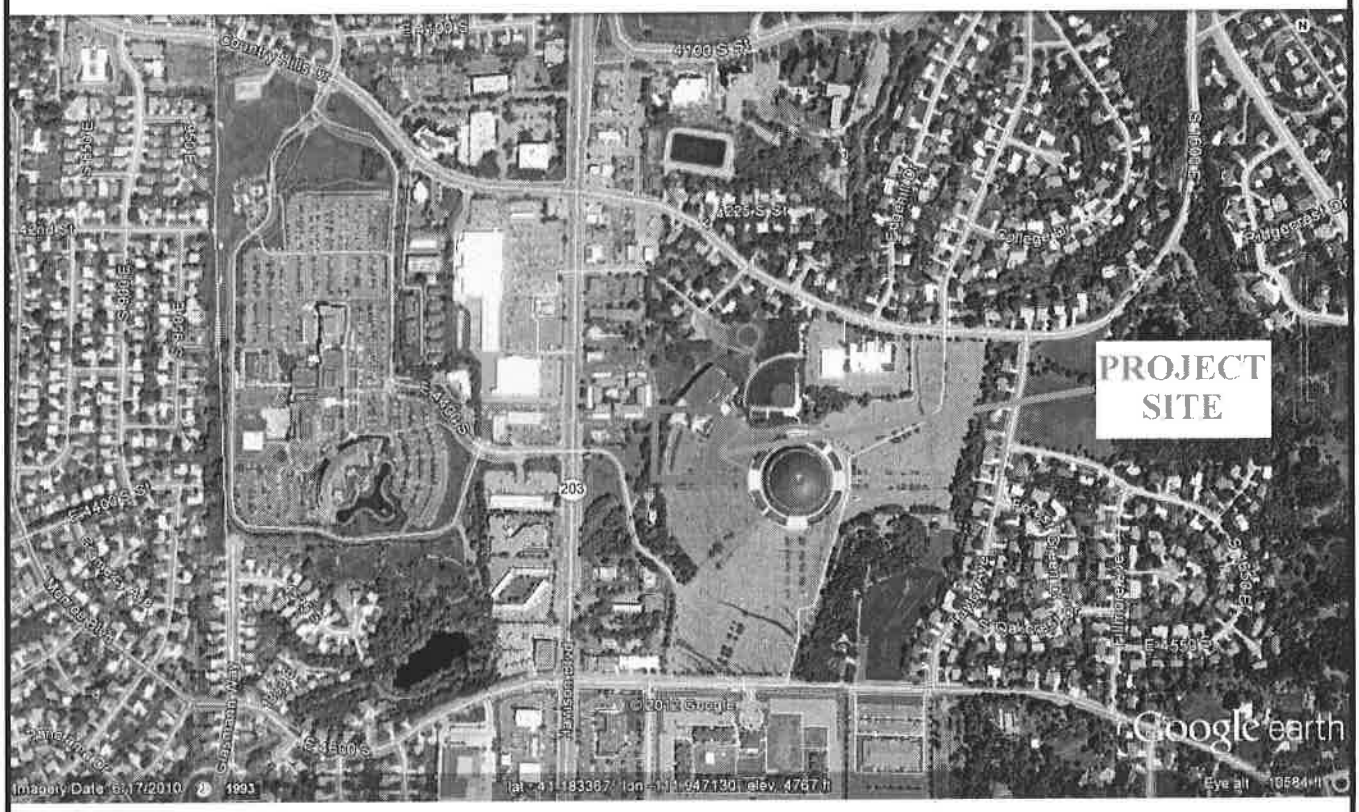

Figure 1: VICINITY MAP

GEOTECHNICAL STUDY
The Ice Sheet Addition
Ogden, Weber County, Utah

Y² Job No. 12G-019

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NORTH

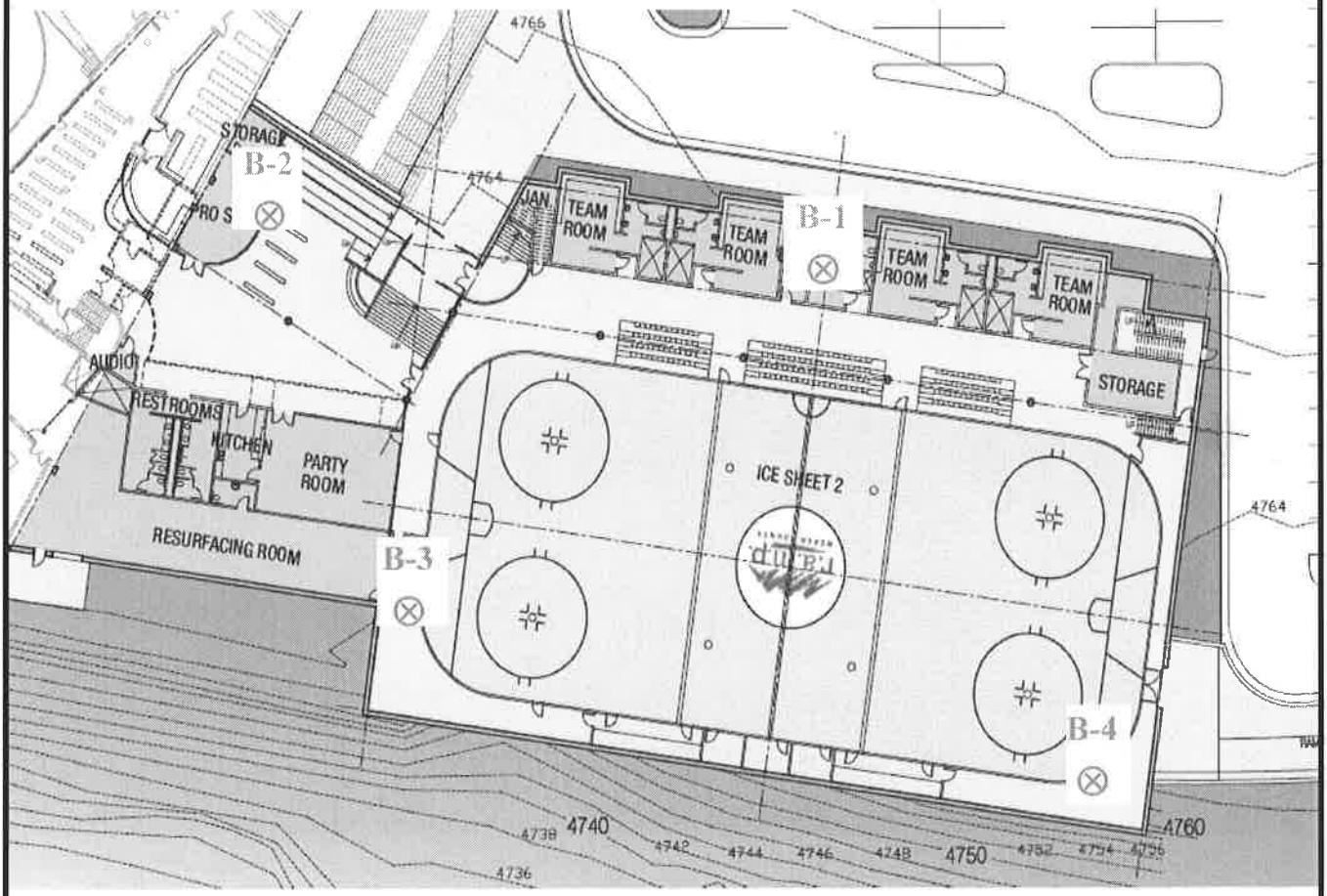


Figure 2: TEST HOLE LOCATIONS

GEOTECHNICAL STUDY
The Ice Sheet Addition
Ogden, Weber County, Utah

Y² Job No. 12G-019

Project No. 12G-019	LOG OF BOREHOLE NO. B-1	Figure 3

PROJECT: The Ice Sheet Addition	CLIENT: Weber County
LOCATION: 4390 Harrison Blvd, Ogden, UT	Surface Elev.:

Standard Penetration Test ☒ | Modified California Sampler ⧓

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	SPT (N) Blows/Foot	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Fines, %
			3" Asphalt							
			12" Road base.							
			21" Fill - silty sand, medium dense, slightly moist, brown.							
			Poorly Graded Sand with Silt (SP-SM) - loose to medium dense, slightly moist to moist, brown to dark brown.	14						
5				13						
				5	5.9	NP	NP	0.9	89.6	9.5
10			Dark brown to red brown below 10 feet.	12						
			Occasional thin clay seams below 11.5 feet.	8						
			End of borehole at 14 feet.							
15										
20										
25										
30										

Y^2 Geotechnical, P.C. Geotechnical, Geologic & Environmental	WATER LEVELS: None 4/9/12	STARTED: 4/9/12	FINISHED: 4/9/12
		DRILL CO.: Y-Squared	DRILL RIG: AMS VTR 9500
		DRILL TYPE: 6" Continuous Flight	
		LOGGED BY: Lori S. Yahne, P.E.	

LOG OF BOREHOLE/TEST PIT 12G-019 GINT.GPJ Y2 GEOTECH.GDT 4/24/12

Project No. 12G-019

LOG OF BOREHOLE NO. B-2

Figure 3

PROJECT	CLIENT
The Ice Sheet Addition	**Weber County**
LOCATION **4390 Harrison Blvd Ogden, UT**	Surface Elev.:

Standard Penetration Test ☒ | Modified California Sampler ⧓

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	SPT (N) Blows/Foot	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Fines, %
			5" Asphalt							
			12" Road base.							
			25" Fill - mixed clay and sand, medium dense, slightly moist, brown.							
		☒	Poorly Graded Sand with Silt (SP-SM) - medium dense to dense, slightly moist to moist, brown to dark brown.	29						
5		⧓		44						
10		⧓		23	5.4	NP	NP	2.2	89.7	8.1
			End of borehole at 12 feet.							
15										
20										
25										
30										

	WATER LEVELS			
Y^2 Geotechnical, P.C.	None 4/9/12	STARTED 4/9/12	FINISHED 4/9/12	
Geotechnical, Geologic & Environmenta		DRILL CO. Y-Squared	DRILL RIGAMS VTR 9500	
		DRILL TYPE 6" Continuous Flight		
		LOGGED BY Lori S. Yahne, P.E.		

LOG OF BOREHOLE/TEST PIT 12G-019 GINT.GPJ Y2 GEOTECH.GDT 4/24/12

Project No. 12G-019	LOG OF BOREHOLE NO. B-3	Figure 3

PROJECT: The Ice Sheet Addition	CLIENT: Weber County
LOCATION: 4390 Harrison Blvd, Ogden, UT	Surface Elev.:

Standard Penetration Test ☒ Modified California Sampler ⧓

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	SPT (N) Blows/Foot	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Fines, %
			3" Asphalt							
			12" Road base.							
			33" Fill - with some cobbles, large root encountered at 4 feet, medium dense to very dense, slightly moist, brown.	56						
5			Poorly Graded Sand with Silt (SP-SM) - dense, slightly moist to moist, dark brown to gray.	45	11.4	NP	NP	0.1	89.8	10.1
10			Slightly cemented below 10.5 feet.	53						
			End of borehole at 11.5 feet.							
15										
20										
25										
30										

Y^2 Geotechnical, P.C.	WATER LEVELS	STARTED 4/9/12	FINISHED 4/9/12
Geotechnical, Geologic & Environmenta	None 4/9/12	DRILL CO. Y-Squared	DRILL RIG AMS VTR 9500
		DRILL TYPE 6" Continuous Flight	
		LOGGED BY Lori S. Yahne, P.E.	

LOG OF BOREHOLE/TEST PIT 12G-019 GINT.GPJ Y2 GEOTECH.GDT 4/24/12

Project No. 12G-019	LOG OF BOREHOLE NO. B-4	Figure 3

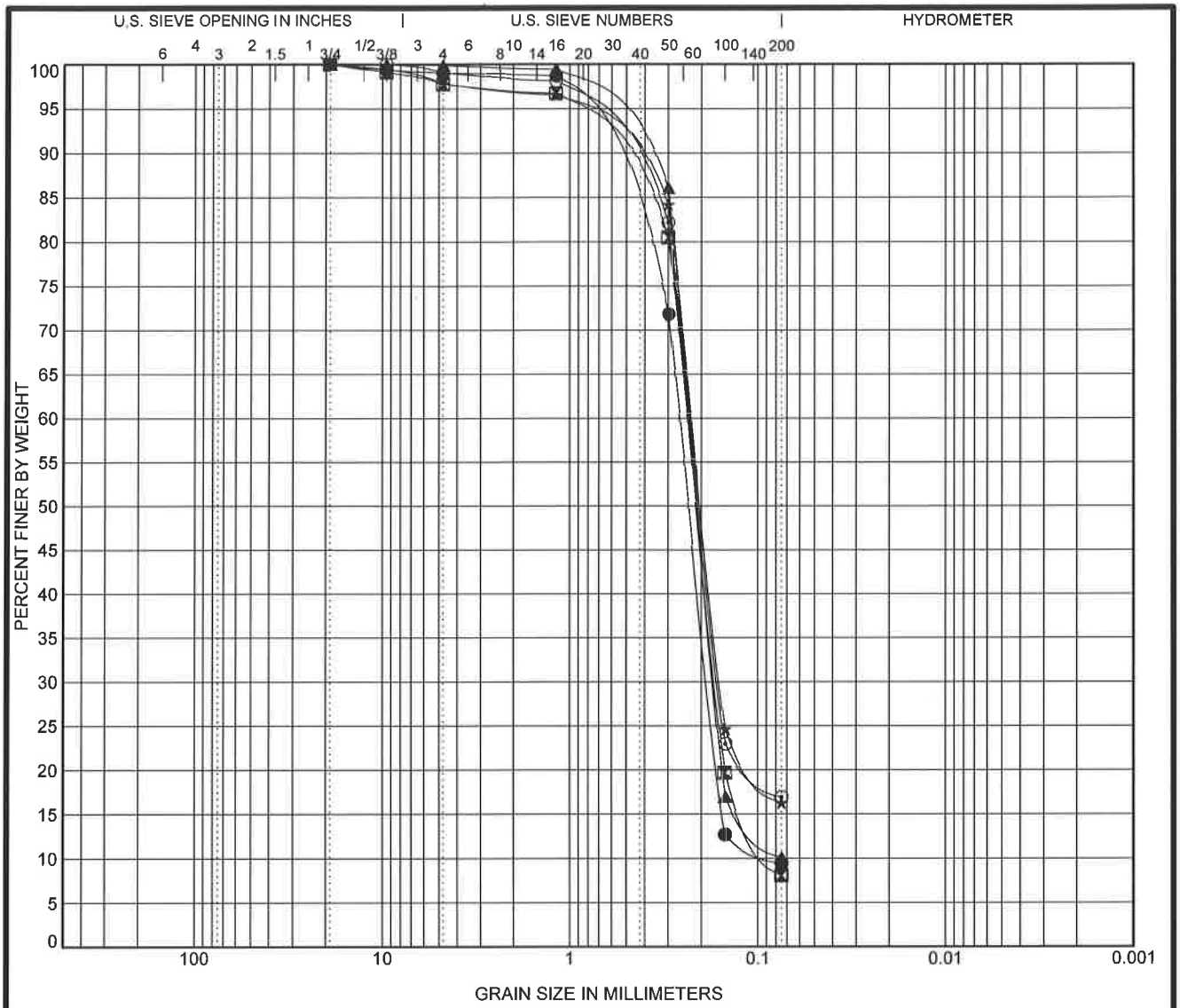
PROJECT	The Ice Sheet Addition	CLIENT	Weber County
LOCATION	4390 Harrison Blvd Ogden, UT	Surface Elev.:	

Standard Penetration Test ☒ Modified California Sampler ⧓

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	SPT (N) Blows/Foot	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Fines, %
			5" Asphalt							
			12" Road base.							
			25" Fill - mixed sand and clay, dense, slightly moist, brown.							
		☒	Silty Sand (SM) - dense to very dense, slightly moist to moist, brown to dark brown.	41	8.8	NP	NP	2.2	81.5	16.3
5		⧓		53						
10		⧓		60						
15		⧓		65	8.7	NP	NP	0.9	82.2	16.9
			End of borehole at 16.5 feet.							
20										
25										
30										

Y^2 Geotechnical, P.C.	WATER LEVELS	STARTED 4/9/12	FINISHED 4/9/12
Geotechnical, Geologic & Environmenta	None 4/9/12	DRILL CO. Y-Squared	DRILL RIG AMS VTR 9500
		DRILL TYPE 6" Continuous Flight	
		LOGGED BY Lori S. Yahne, P.E.	

LOG OF BOREHOLE/TEST PIT 12G-019 GINT.GPJ Y2 GEOTECH.GDT 4/24/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	7.0	POORLY GRADED SAND with SILT(SP-SM)	NP	NP	NP	1.54	3.11
⊠	B-2	10.0	POORLY GRADED SAND with SILT(SP-SM)	NP	NP	NP	1.42	2.82
▲	B-3	5.0	POORLY GRADED SAND with SILT(SP-SM)	NP	NP	NP	1.71	3.12
★	B-4	2.5	SILTY SAND(SM)	NP	NP	NP		
⊙	B-4	15.0	SILTY SAND(SM)	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	7.0	19.1	0.261	0.184	0.084	0.9	89.6	9.5	
⊠	B-2	10.0	19.1	0.237	0.169	0.084	2.2	89.7	8.1	
▲	B-3	5.0	9.53	0.231	0.171		0.1	89.8	10.1	
★	B-4	2.5	19.1	0.226	0.16		2.2	81.5	16.3	
⊙	B-4	15.0	9.53	0.231	0.163		0.9	82.1	16.9	

Y² Geotechnical, P.C.

Geotechnical, Geologic & Environmental

GRAIN SIZE DISTRIBUTION

Project: The Ice Sheet Addition

Location: 4390 Harrison Blvd Ogden, UT

Number: 12G-019

US GRAIN SIZE 12G-019 GINT.GPJ Y2 GEOTECH.GDT 4/24/12

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	7.0	NP	NP	NP	19.1	10	SP-SM	5.9			
B-2	10.0	NP	NP	NP	19.1	8	SP-SM	5.4			
B-3	5.0	NP	NP	NP	9.53	10	SP-SM	11.4			
B-4	2.5	NP	NP	NP	19.1	16	SM	8.8			
B-4	15.0	NP	NP	NP	9.53	17	SM	8.7			

Y^2 *Geotechnical, P.C.*

Geotechnical, Geologic & Environmental

Summary of Laboratory Results

Project: The Ice Sheet Addition

Location: 4390 Harrison Blvd Ogden, UT

Number: 12G-019