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CONSTRUCTION DOCUMENTS
PROJECT MANUAL
VOLUME 2

ROOSEVELT MIDDLE SCHOOL
EUGENE SCHOOL DISTRICT 4J
EUGENE, OREGON

CIP NO. 410.566.001

FEBRUARY 18, 2015

PROJECT TITLE PAGE – VOLUME 2

PROJECT TITLE:

ROOSEVELT MIDDLE SCHOOL REPLACEMENT PROJECT

CIP No. 410.566.001

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18 FEBRUARY 2015

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COMMON WORK RESULTS FOR FIRE SUPPRESSION

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 calls for design-build work. Provide a complete working automatic sprinkler system for the entire building as shown, specified and required by applicable codes.

B. Piping and sprinkler head locations shall meet the Architectural design intent for the building in addition to complying with specifications and applicable codes. The right is reserved to make any reasonable changes in sprinkler head location prior to roughing-in, without cost impact.

C. Related Sections include Section 21 10 00 Water Based Fire Suppression Systems.

1.3 QUALITY ASSURANCE

A. All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations.

B. Contractor shall obtain and pay for all permits, licenses and inspection.

C. Materials and equipment shall be UL listed except for pipe that meets the requirements of Table 6.3.1.1, fittings that meet Table 6.4.1, and hangers that meet section 9.1 of NFPA 13.

D. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects and in conformance with the Contract Documents.

E. Apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

F. All equipment shall be installed level and true.

G. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.

H. Follow manufacturer’s installation directions.

I. Cutting and Patching:
   1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate Division.
   2. Additional openings required in building construction shall be made by drilling or cutting. Use of jackhammer is prohibited.
   3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
   4. Beams or columns shall not be pierced without permission of Architect.
   5. All new or existing work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks or other landscaping, the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Prepare fire protection system shop drawings showing locations and types of head or outlets, alarm valves and devices, pipe sizes and cutting lengths, test tees and valves, drain valves, and other related items. Shop drawings shall be new drawings prepared by Contractor. Overlay drawings with shop drawings of other trades and check for conflicts. Drawings shall be same size as Architect's Drawings with similar title block. Drawings shall be fully dimensioned including both plan and elevation dimensions.
   2. Shop drawings shall include:
      a. Sprinkler head layout drawings overlaid with ceiling and floor plans.
      b. Sprinkler floor plans, including all piping, equipment and heads to a minimum scale of 1/8-inch equals 1'-0" or same as plans, whichever is greater.
      c. Beam penetration drawings indicating beam penetrations at a minimum scale of 1/4" = 1'-0".
      d. Fabrication drawings of architectural wooden ceilings and skylight areas, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.
      e. Hydraulic calculation information may be included.
   3. Submit shop drawings to Architect for review and approval prior to submittal to Authority Having Jurisdiction. Contractor may request a design coordination meeting with Architect prior to submitting shop drawings.
   4. Additional shop drawings may be requested if it appears that coordination issues are not being resolved in the field.

B. Product Data: Submit product data for all equipment. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets shall include capacities, pressure drop, design and operating pressures, installation procedures and similar data.

C. Submit certificates and test reports as required by NFPA 13.

D. Submission Requirements:
   1. Refer to Division 1 for additional requirements related to submittals.
   2. Shop Drawings:
      a. Provide three sets of shop drawings, hydraulic calculations and product data to Architect for review.
      b. Submit six sets of Authority Having Jurisdiction-approved drawings to Architect.
   3. Product Data:
      a. Submit electronic copies of product data in PDF format with each item filed labeled with its respective specification section number, article and paragraph and mark, if applicable.
      b. Include a complete index in the submittal.
      c. All product data shall be submitted in a single submittal. Partial submittals will not be accepted.

E. It shall be the Contractor's responsibility to:
   1. See that all submittals are submitted at one time and are in proper order.
   2. Ensure that all equipment will fit in the space provided.
   3. Assure that all deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.5 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

A. Refer to Division 1 for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature shall be on 8-1/2"x11" sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for all electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions shall cover all phases of control.

D. Furnish competent engineer knowledgeable in this building system for minimum of one 8-hour day to instruct Owner in operation and maintenance of systems and equipment. Contractor shall keep a log of this instruction including dates, times, subjects, and those present and shall present such log when requested by Architect.

1.6 PROJECT CONDITIONS

A. Prior to bidding, become familiar with existing conditions by visiting the site.

B. Coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before fabricating work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities with Owner.

1.7 WARRANTY

A. Provide a written guarantee covering the work of this Division for a period of one calendar year from the date of Owner acceptance as defined in the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance as defined in the General Conditions.

1.8 TEST REPORTS AND CERTIFICATES

A. Submit one copy of test reports and certificates to the Architect.

1.9 SUBSTITUTIONS

A. Submit any requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Provide as specified in Architectural Divisions.

2.2 PIPE SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel or pre-approved water tight system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction.

C. Exterior Wall and On Grade Floor Sleeves: Cast iron.

2.3 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:
   1. Floor Plates: Cast brass, chromium plated.
   2. Wall and Ceiling Plates: Spun aluminum.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate fire protection piping and appurtenances with ducts, other piping, electrical conduit, and other equipment.

B. All fire protection piping and equipment shall be concealed except in area without ceilings.

C. In general, sprinklers shall be located in the center of ceiling panels and symmetrically within rooms and down corridors, coordinated with and in pattern with lights and grilles. Deviations must be approved by the Architect.

3.2 SLEEVES

A. Interior Floor and Wall Sleeves: Provide sleeves large enough to provide clearances around pipe outside diameter as required by NFPA. Make watertight by packing with safing insulation and sealing.

B. Sleeves through Rated Floors and Walls: Similar to interior sleeves except install fire-rated system approved by Authority Having Jurisdiction.

C. Exterior Wall Sleeves Below Grade: Make watertight with using link-seal modular wall and casing seal or lead and oakum. Caulk from outside.

D. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, except caulk from inside.

E. Exterior Wall Sleeves Above Grade: Same as interior wall sleeves, except caulk from outside.

F. All floor sleeves shall maintain a water barrier by providing a water tight seal or they shall extend 1 inch above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2 inches above finished floor level. Sleeves through roof shall extend 8 inches above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated. Sleeves through planters shall extend 8 inches above planter base.

3.3 FLOOR, WALL AND CEILING PLATES

A. Install on piping passing through finished walls, floors, ceilings, partitions and plaster furrings. Plates shall completely cover opening around pipe and duct.

B. Secure wall and ceiling plates to pipe or structure.

C. Plates are not required in mechanical rooms or unfinished spaces.

3.4 CLEANING

A. Clean equipment and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel.

3.5 EQUIPMENT PROTECTION

A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated equipment or apparatus to original conditions or replace at no cost to Owner.

B. No rusted material is permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.6 ACCESSIBILITY

A. Locate valves, indicating equipment or specialties requiring frequent reading, adjustments or inspection conveniently and accessibly.

B. Install gauges so as to be easily read from the floors.

3.7 PAINTING

A. Exposed to View:
   1. Hangers: One coat rust inhibiting primer and final coat of black enamel.
   2. Sprinkler Piping: One coat rust inhibiting primer and final coat of black enamel.
   3. Steel Valve Bodies and Bonnets: One coat of black enamel.
   4. Brass Valve Bodies: Not painted.
   5. Sprinkler Heads: Not painted.

B. Concealed from View (above ceilings, not visible):
   1. Not painted.

3.8 CLEANING

A. Clean interior of all piping before installation.

B. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed in accordance with manufacturer’s instructions.

3.9 ELECTRICAL EQUIPMENT

A. Fire Suppression systems shall not pass over switchboards or electrical panelboards.

END OF SECTION

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 1 Specification Sections, apply to this Section.

B. The provisions of Section 21 05 00, Common Work Results for Fire Suppression apply to work specified in this Section.

1.2 SUMMARY

A. This Section calls for design-build work. Provide a complete working automatic fire sprinkler system with zoning layout as shown, specified and required by applicable codes.

1.3 QUALITY ASSURANCE

A. All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations, including in particular NFPA 13 and 14.

B. NFPA 13 (without the use of exceptions found in NFPA 13 systems minimum guideline) shall be used for the location, sizing, and installation of piping and sprinkler systems unless local fire marshal or owner's insurance underwriter requirements are more stringent. Exceptions must be approved by the Engineer prior to usage.

C. Water Service Information: Contractor shall obtain current flow test information prior to starting their design of the fire sprinkler/standpipe system.

1.4 SUBMITTALS

A. Provide submittal in accordance with Section 21 05 00.

PART 2 - PRODUCTS

2.1 SPRINKLER HEADS

A. Fire sprinklers shall be of one manufacturer throughout building.

B. Sprinklers Installed in Finished Ceilings: Quick response, recessed, bulb type, white finish, 165°F unless required otherwise. Sprinklers at wood ceilings shall be chrome.

C. Sprinklers Installed in Unfinished Ceiling Areas (or Above Finished Ceilings Where Required): Pendant or up-right fusible solder type, rough bronze finish and shall be of adequate temperature for the hazard.

D. Sprinklers Installed in Exterior Covered Areas: Quick response, dry pendant fusible solder type, chrome finish, 165°F unless required otherwise.

2.2 UTILITY MARKERS

A. Provide plastic tape utility markers over all buried piping. Provide identification on tape.

B. Material to be Brady Identoline plastic tape, 6-inch, Seton, or approved equal.

2.3 VALVE IDENTIFICATION

A. Valve Tags:
   1. General: Identify valves with metal tags or plastic signs, legends to be stamped or embossed. It shall indicate the function of the valve and its normal operating position, and area served; i.e.,

      GRD LVL (Area Served)
      ISOLATION (Valve Function)
      NO (Normal Operation Position)

   2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
   3. Material: Use 0.050 or 0.064-inch brass tags.
   4. Control Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, “lamicoid” or equal. Form letters by exposing center ply.

B. Valve Tag Directory: Include tag number, location, exposed or concealed, area served, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.4 PIPING MARKERS

A. Pipe not visible from occupied space shall be labeled with all-vinyl, self-sticking labels or letters. For pipe covering sizes up to and including 3/4-inch outside diameter, use labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters. The pipe markers shall have a red background with black letters saying FIRE PROTECTION WATER with black directional arrows.

2.5 DRY PIPE SYSTEM

A. Where needed, use system similar to Viking Total-Pac 3. Cabinet assembly shall be pre-assembled, pre-wired, and factory tested will all hydraulic, pneumatic and electrical components required for the control of the dry pipe system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all items in accordance with manufacturers’ instructions.

B. Drain all piping per NFPA 13. If drain piping is discharged to outside, provide splash plate in a location approved by the architect.

3.2 EXTRA STOCK

A. Provide additional number of heads of each type and temperature rating installed as required to meet NFPA 13 requirements.

B. Provide storage cabinet or cabinets as required to receive reserve sprinkler heads and special installation tools required.

C. Provide index label for each head indicating manufacturer, model, orifice size of K-factor, and temperature rating.

D. Provide, inside cabinet, a list of heads stored within and brief description of where installed.

E. Locate cabinet in a location approved by the architect.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform all tests and arrange for required inspections of installed system as required.
   2. Notify the Owner and Architect 48 hours prior to any test or inspection.

END OF SECTION

COMMON WORK RESULTS FOR PLUMBING

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 provisions of This Section, Common Work Results for Plumbing, apply to all sections in Division 22.

C. All Sections of Division 22 are interrelated. When interpreting any direction, material, and method specified in any section of Division 22 consider it within the entirety of Work in Division 22.

1.2 SUMMARY

A. The intent of Division 22 Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 22 and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

B. The Division 22 Specifications and the accompanying Drawings are complementary and what is called for by one shall be as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications shall supersede drawings in case of conflict.

C. Imperative language is frequently used in Division 22 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.

D. The Drawings that accompany the Division 22 Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions shall be assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in fixture location prior to roughing-in, without cost impact.

1.3 RELATED WORK

A. The General and Supplemental Conditions apply to this Division, including but not limited to:
   1. Drawings and specifications.
   2. Public ordinances, permits.
   3. Include payments and fees required by governing authorities for work of this Division.

B. Division 1, General Requirements, applies to this Division.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All products and equipment shall comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
   2. General: All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations.
   3. Contractor responsible for obtaining and payment for all permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire plumbing system and apparatus shall operate at full capacity without objectionable noise or vibration.

E. All equipment shall be installed level and true. Housekeeping pads and curbs shall account for floor or roof slope.

F. Materials and Equipment:
   1. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name along with other manufacturers.
   2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
   3. Furnish all materials and equipment of size, make, type, and quality herein specified.
   4. Equipment scheduled by performance or model number shall be considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for all changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:
   1. General: All materials shall be installed in a neat and professional manner.
   2. Manufacturer’s Instructions: Follow manufacturer’s directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 22 Specifications, obtain clarification before starting work.

H. Cutting and Patching:
   1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
   2. Additional openings required in building construction shall be made by drilling or cutting. Use of jackhammer is specifically prohibited.
   3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
   4. Beams or columns shall not be pierced without permission of Architect and then only as directed.
   5. All new or existing work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.5 SUBMITTALS

A. Submit in accordance with section 01 33 00- Submittal Procedures.

B. Shop Drawings:
   1. The Contract Drawings indicate the general layout of the piping, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of all piping, and equipment installations. Shop Drawings shall be new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. All drawings shall be same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. All drawings shall be fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
   2. Shop drawings shall be prepared in [three-dimensional] [two-dimensional] format.
   3. Shop drawings shall include but are not limited to:
      a. Plumbing site plan drawn to same scale as Site Plan.
      b. Complete floor plans with plumbing to a minimum of 1/4-inch equals 1'-0" scale.
      c. Plumbing in mechanical rooms to a minimum of 1/2-inch equal 1'-0" scale.
      d. Sections of congested areas to a minimum of 1/2-inch = 1'-0" scale.
      e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment shall not be less than 1/2-inch equals 1'-0" scale.
      f. Superplot plans of above ground work with a colored overlay of all trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2" = 1"-0" scale.
      g. Superplot plans of below ground work with a colored overlay of all trades including, but not limited to, structural footings and foundation, HVAC piping, civil piping, plumbing piping, and power conduit to a minimum of 1/2" = 1"-0" scale.
      h. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4" = 1'-0" scale.
      i. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1"-0" scale.
   4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

C. Product Data:
   1. In general, submit product data for review on all scheduled pieces of equipment, on all equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets shall include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
   2. List the name of the motor manufacturer and service factor for each piece of equipment.
   3. Indicate equipment operating weights including bases and weight distribution at support points.
   4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

D. Submission Requirements:
   1. Shop Drawings and Product Data:
      a. Refer to Division 1 for additional requirements related to submittals.
      b. Submit copies of shop drawings and product data for Work of Division 22 in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, article and paragraph, and mark if applicable.
      c. Submit electronic copies of shop drawings and product data for Work of Division 22 in PDF format with each item filed under a folder and labeled with its respective specification section number, article, and paragraph and mark, if applicable.

d. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
e. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, shall be included with the original submittal. Controls and Instrumentation submittals may lag but shall be complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder shall include a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

E. Contractor Responsibilities: It shall be the Contractor's responsibility to:
1. See that all submittals are submitted at one time and are in proper order.
2. Ensure that all equipment will fit in the space provided.
3. Assure that all deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.6 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

A. Refer to Division 1 for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature shall be on 8-1/2"x11" sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for all electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions shall cover all phases of control.

D. Furnish competent engineer knowledgeable in this building system for minimum of five 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Contractor shall keep a log of this instruction including dates, times, subjects, and those present and shall present such log when requested by Architect.

1.7 PROJECT CONDITIONS

A. Existing Conditions: Prior to bidding, verify and become familiar with all existing conditions by visiting the site, and include all factors which may affect the execution of this Work. Include all related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City and Utility Company.

1.8 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.9 PROVISIONS FOR LARGE EQUIPMENT

A. Contractor shall make provisions for the necessary openings in building to allow for admittance of all equipment.

1.10 TEST REPORTS AND CERTIFICATES

A. Contractor shall submit one copy of all test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

A. Contractor shall submit any requests for product substitutions in accordance with the Instructions to Bidders, section 01 60 00 – Product Requirements and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Furnish under this Division as specified in section 08 31 00-Access Doors & Panels.

2.2 PIPE SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron.

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.3 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:
   1. Floor Plates: Cast brass, chromium plated.
   2. Wall and Ceiling Plates: Spun aluminum.

2.4 MACHINERY GUARDS

A. Furnish guards for protection on all rotating and moving parts of equipment. Provide guards for all metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.

B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.

C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards shall be easily removable for pulley adjustment or removal and changing of belts.

D. All guards shall meet OSHA requirements including back plates.

E. Provide inlet and outlet screens on all fans in plenums or where exposed to personnel.

2.5 ELECTRICAL EQUIPMENT

A. General: All equipment and installed work shall be as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available interrupting current (AIC) rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment that meets the bracing requirement.

C. Motors:
   1. Motors shall be furnished as integral part of driven equipment. They shall be drip-proof induction type with ball bearings unless noted otherwise. Motors 1 HP and above shall be premium energy efficient type, except for emergency equipment motors. Motors shall be built to NEMA Standards for the service intended. The motors shall be rated for the voltage specified, suitable for operation within the range of 10% above to 10% below the specified voltage.
   2. Energy efficient motors shall be Baldor, Westinghouse, General Electric or approved equal.
   3. The motor shall meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	**KW**	**900**	**1200**	**1800**	**3600**
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5
7.5	5.6	87.5	91.7	91.7	91.0

   4. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage and phase.
   5. Refer to individual product sections for additional motor requirements.
   6. Motors shall have built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors shall have quick trip devices.
   7. All motors controlled by variable frequency drives shall be inverter duty rated and have Class F insulation or better. They shall also be able to withstand repeated voltage peaks of 1600 volts with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
   8. Motors served from variable frequency drives shall be equipped with shaft grounding system which shall provide a path for current to flow between the shaft and motor frame. SGS or equal.

D. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

E. Equipment Wiring: Interconnecting wiring within or on a piece of mechanical equipment shall be provided with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

F. Control Wiring: All control wiring for plumbing equipment shall be provided herewith.

G. Codes: All electrical equipment and products shall bear the Underwriters label as required by governing codes and ordinances.

PART 3 - EXECUTION

3.1 ACCESS PANELS

A. Install in accord with manufacturer’s recommendations, coordinated with architectural features.

B. Provide 1-hour and 2-hour fire rated doors where required bearing the U.L. label.

C. Furnish 18x18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12x12-inch for walls unless indicated otherwise.

D. Furnish where indicated and where required to access valves, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.2 SLEEVES

A. Interior Floor and Wall Sleeves: Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork. Where pipe or ductwork is insulated, insulation shall pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve. Penetrations through mechanical room and fan room floors shall be made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Sleeves Through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves Below Grade: Provide water tight sleeves. Install at pipes entering building below grade and where shown. Adjust to provide positive hydrostatic seal. Contractor shall be responsible for following manufacturer's procedure for installing and tightening seal. Secure sleeves against displacement.

D. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

E. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

F. Layout work prior to concrete forming. Do all cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

G. All floor sleeves shall maintain a water barrier by providing a water tight seal or they shall extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2 inches above finished floor level. Sleeves through roof shall extend 8 inches above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated. Waste stacks using carriers shall have sleeves flush with floor and sealed. Sleeves through planters shall extend 8 inches above planter base.

H. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.

I. Special sleeves detailed on drawings shall take precedence over this section.

3.3 CLEANING

A. General: Clean plumbing equipment, fixtures and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.4 EQUIPMENT PROTECTION

A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.5 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms and walkways.

3.6 FLOOR, WALL AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates shall completely cover opening around pipe.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates shall not penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.7 PAINTING

A. General: Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting. All exposed work under this division shall receive either a factory painted finish or a field prime coat finish, except:
   1. Exposed copper piping.
   2. Aluminum jacketed outdoor insulated piping.

B. Equipment Rooms and Finished Areas:
   1. Insulation: Not painted.
   2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
   3. Steel Valve Bodies and Bonnets: One coat of black enamel.
   4. Brass Valve Bodies: Not painted.
   5. Equipment: One coat of grey machinery enamel. Do not paint nameplates.

C. Concealed Spaces (above ceilings, not visible):
   1. Insulation: Not painted.
   2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.

D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.

E. Exterior Black Steel Pipe: Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel. Painting schemes shall comply with ANSI A13.1.

3.8 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by overlubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.9 ELECTRICAL EQUIPMENT

A. Piping for plumbing systems not serving electrical space shall not be installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Piping for plumbing systems shall not pass over switchboards or electrical panel boards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

A. Make final connections to equipment specified in sections other than Division 22 of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.

B. Piping:
   1. Connections shall include hot and cold water, natural gas, sanitary waste and vent, lab waste and vent.
   2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
   3. All piping connections shall be independently supported to prevent undue strain on equipment.

C. Refer to Specification Section 11 40 00 Food Service Equipment.

END OF SECTION

VARIABLE FREQUENCY DRIVES FOR PLUMBING EQUIPMENT

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Variable frequency drives.

1.3 SUBMITTALS

A. Submit the following:
   1. Product data on variable frequency drives and related components.
   2. Startup log/check list showing successful operation.
   3. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Acceptable Manufacturers:
   1. Reliance, Toshiba, ABB, Emerson, Yaskawa, Square D, Siemens, Saftronics, and Allen-Bradley.
   2. Other Manufacturers: Submit substitution request.

B. General Description:
   1. Variable frequency AC motor drive (VFD) to be of pulse width modulated (PWM) inverter type. The VFD designed to convert 60 Hz input power to adjustable frequency output power to provide positive speed control to standard induction motors. The VFD to be dedicated variable torque design for specific use with centrifugal loads.
   2. Provide completely solid state variable frequency power and logic unit.
   3. Speed control to be stepless throughout the range under variable torque load on continuous basis. Speed controlled by remote building energy management system providing 4-20MA input signal to drive and remote start/stop signal. Coordinate with Section 23 09 00.
   4. Provide adjustable frequency control with diode bridge/capacity input designed to provide high, constant power factor of 0.95 regardless of load or speed and eliminate SCR line noise.
   5. Equipment will be designed and manufactured in accordance with applicable current NEMA and IEEE recommendations and be designed for installation per NEC. Equipment will be UL listed and bear the UL label.
   6. Control shall be suitable for operation in ambient temperatures of 0 to 40°C.
   7. Every VFD shall be factory tested with an AC induction motor 100% loaded and temperature cycled within an environmental chamber at 104°F.

C. Self-Protection and Reliability Features:
   1. Adjustable current limit to 60 to 110% of drive rating.
   2. Adjustable instantaneous overcurrent trip.
   3. Under voltage trip.
   4. Over temperature trip.
   5. Short circuit protection phase to phase and phase to ground faults phase rotation insensitive.
   6. Momentary power loss, more than 17 milliseconds.
   7. Transient protection against all normal transients and surges in incoming power line.

8. Orderly shutdown in event of any of above conditions, drive shall be designed to shut down safely without component failure.
9. Provide visual indication and manual reset.

D. Standard Features:
1. Drive logic shall be microprocessor based. Control logic shall be isolated from power circuitry.
2. Standalone operation to facilitate start up and troubleshooting procedures.
3. VFD shall be UL 508C listed for drives serving a single motor or UL 508A listed for drives serving multiple motors, for use on distribution systems with 22,000 AIC.
4. Output voltages shall be equal to applied input voltage.
5. Isolated signal inputs.
6. Frequency Stability. Output frequency will be held to +0.1% of maximum frequency regardless of load, +10% input voltage change or temperature changes within ambient specification.
7. Built-in digital display shall indicate output frequency, voltage and current and shall provide indication of over current, over voltage, current limit, ground fault, over temperature, input power on, minimum or maximum speed adjustment, power on, fault condition. Display shall be on panel face.
8. Start/Stop Control - Controlled decelerated stop.
9. Primary and secondary fused for a control circuit transformer.
10. Minimum and maximum speed control.
11. Adjustable Accel/Decel - independently adjustable 10-100 second.
12. Hand-Off auto switches.
13. Programmable Auto Restart - after power outage.
14. Provide fused disconnect, including auxiliary contacts to isolate control circuit when disconnect is in “off” position, except fused disconnects not required where packaged equipment is provided with a single point connection with single point disconnect and internal overcurrent protection for VFD and motors.
15. Remote contacts for fault, and on/off status.
16. Adjustable motor output voltage.
17. Analog output voltage of 0-10 VDC, -20 MA proportional to control output frequency.
18. Provide a NEMA 1 enclosure for indoor applications and NEMA 3R enclosure for outdoor applications to isolate each motor starter and control section with its associated disconnect switch.
19. Manual speed control for each motor.

E. Communications:
1. Provide factory installed communication chip for direct network connection to DDC Control System specified in Section 23 09 93. Interface shall allow for all control and interface functions specified herein and in Section 23 09 93. Interface control functions and information shall include, but not be limited to the following:
    a. Start/Stop
    b. Change Directions
    c. Drive Fault
    d. Drive Fault Codes
    e. Reset Drive
    f. Percent Output
    g. Speed
    h. Power
    i. Drive Temp
    j. KWH
    k. Run Time
2. Provide isolated analog output signals for volts, amps and frequency from each VFD for connection to the DDC Control System specified in Section 23 09 93.
3. Provide RS485 communications port and programming software capability.

PART 3 - EXECUTION

3.1 VARIABLE FREQUENCY DRIVE INSTALLATION

A. Install VFD in accordance with manufacturer's written installation instructions.

B. Install on strut support stand.

C. Provide one drive for each motor as scheduled.

3.2 START UP

A. General: Comply with manufacturer's instructions for startup.

B. Startup shall be provided under the direct supervision of the manufacturer's representative with factory trained personnel.

3.3 FIELD QUALITY CONTROL

A. Prior to installation, manufacturer's representative shall coordinate variable speed drive control interface with the controls contractor and verify that intended installation (controls, wiring, etc.) complies with the manufacturer's recommendations.

B. Field Test: Except where initial variable speed drive operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests performed by the manufacturer's representative in the presence of the Engineer.

END OF SECTION

PLUMBING EXPANSION COMPENSATION

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Expansion joints and compensation.

B. Related Sections include:
1. Section 22 05 29 Hangers, Supports and Anchors for Plumbing.
2. Section 22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment
3. Section 22 21 13 Pipe and Pipe Fittings Plumbing.

1.3 QUALITY ASSURANCE

A. The expansion loops and related supports, braces, and anchorages to building structure shall be designed to absorb thermal expansion and contraction of piping and terminal movement, as well as resist the static and dynamic loads due to fluid flow at design conditions, hydraulic testing pressures, and seismic forces.

B. The system of expansion loops and related supports, braces, and anchorage to building structure shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.

C. Design shall include:
1. Pipe stress analysis indicating loads, deflections, and pipe stress at critical points throughout the piping systems under the following conditions:
    a. At hydraulic design test pressure and ambient water temperature.
    b. At design operating temperature, pressure, and flow.
    c. Detailed shop drawings stamped and signed by a registered professional engineer.
    d. Structural details and calculations stamped and signed by a registered professional structural engineer.

1.4 SUBMITTALS

A. Submit the following:
1. Product data.
2. Shop Drawings showing details of construction, dimensions, arrangement of components, and isolation.
3. Specified testing requirements.
4. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 EXPANSION LOOPS / SEISMIC EXPANSION JOINTS

A. Acceptable Manufacturers:
1. Metraflex Metraloop.
2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Flexible stainless steel hose and braid connector. .
   2. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.
   3. All materials of construction and pressure ratings shall be appropriate for the application as specified for each piping material and service.

PART 3 - EXECUTION

3.1 EXPANSION LOOPS / SEISMIC EXPANSION JOINTS

A. Install at building seismic expansion joints.

B. Install in piping to compensate for thermal expansion and contraction. Contractor is responsible to determine quantities and locations required.

C. Install in other locations indicated on the drawings.

D. Install per manufacturer’s installation instructions.

END OF SECTION

METERS AND GAUGES FOR PLUMBING

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Thermometers, pressure gauges, water meters.

1.3 SUBMITTALS

A. Submit the following:
   1. Products listed in this section.
   2. Water flow meters, include graph of output signal vs. gpm for each device.
   3. Operating and Maintenance Data.

PART 2 - PRODUCTS

2.1 THERMOMETERS, WATER

A. Acceptable Manufacturers:
   1. Ashcroft, Weiss, Trerice, Marsh, Weksler, Tel-Tru.
   2. Other Manufacturers: Submit Substitution Request.

B. Direct drive 5-inch dial type, stainless steel case, separable sockets, stem length to penetrate minimum of 1/2 pipe diameter, adjustable face, extension necks where required to clear insulation.

C. Range:

Plumbing Systems	Temperature °F	Graduations (°F)
Domestic Hot Water	30-180	2
Solar Hot Water	30-240	2

2.2 PRESSURE GAUGES - GENERAL

A. Acceptable Manufacturers:
   1. Marsh, Ashcroft, Weiss, Trerice, Weksler, Tel-Tru.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: 4-1/2-inch dial, molded black polypropylene turret case.

C. Range:

Plumbing Systems	Pressure (psi)	Graduations (psi)
Domestic Hot Water	0-160	1
Solar Hot Water	0-160	1
Other ranges may be listed on Drawings in which case they take precedence		

2.3 WATER METER

A. Acceptable Manufacturers:
   1. Hersey Model HD, similar Badger, Sparling.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Disc type meter, bronze split casing, magnetic drive.
   2. Heavy duty gear train, completely sealed, circular meter, totalize in cubic feet with sweep hand.
   3. Comply with AWWA performance standards.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Provide meters and gauges where shown on Drawings.

B. Install all gauges and meters as required and as recommended by equipment manufacturer or their representative.

C. Extend all connections, wells, cocks, or gauges to a minimum of l-inch beyond insulation thickness of the various systems.

D. Locate all gauges so that they may be conveniently read at eye level or easily viewed and read from the floor or from the most likely viewing area, i.e., platform, catwalk, etc.

E. Install instruments over 6'-6" above floor, to be viewed from the floor, with face at 30 degrees to horizontal.

3.2 INSTALLATION - PRESSURE GAUGES

A. Provide instrument gauge cock at inlets. Locate pressure gauge taps for measuring pressure drop or increase across pumps, etc., as close to the device as possible.

3.3 WATER METER

A. Installed in accord with manufacturer’s recommendations and as shown on the Drawings.

END OF SECTION

GENERAL DUTY VALVES AND SPECIALTIES FOR PLUMBING

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 provisions of Section 22 05 00, Common Work Results for Plumbing, apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Valves, general purpose gauge cocks, and balance fittings.

1.3 SUBMITTALS

A. Submit product data.

1.4 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. PTFE: Polytetraflouroethylene plastic.

H. SWP: Steam working pressure.

I. Lead Free: Refers to the wetted surface of pipe, fittings, and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011. Section 1417 *Add specific state requirements as needed.

1.5 QUALITY ASSURANCE

A. ASME Compliance:
   1. ASME B16.10 for ferrous valve dimensions.
   2. ASME B31.9 for building services piping valves.

B. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER VALVES

A. General: Where only NIBCO INC. figure numbers are listed, equivalent products by those specified below are acceptable.
   1. Globe, Swing Check: Victaulic, Crane, Kennedy, Stockham, Milwaukee, Walworth and Hammond.
   2. Silent Check: Mueller, Metraflex, Victaulic, Bell and Gossett, Milwaukee and Gruvlok.
   3. Balancing: Bell and Gossett, Armstrong, Tour and Anderson, and Nibco.
   4. Butterfly: Victaulic, Gruvlok, Crane, Walworth, Milwaukee and Metraflex.
   5. Ball: Gruvlok, Apollo, Crane, Hammond, Milwaukee and Victaulic.

B. Other Manufacturers: Submit Substitution Request.

C. All such valves shall be of one manufacturer.

D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system. Refer to Section 22 21 13 for allowable fittings.

2.2 GLOBE VALVES

A. Bronze Globe and Angle Globe: Bronze body, bronze mounted, renewable composition disc, 150 psi rating; Nibco 235 or 335.

B. Bronze Globe and Angle Globe High Pressure: Bronze body, stainless steel disc, union bonnet, 300 psi steam; Nibco 276-AP or 376-AP.

2.3 CHECK VALVES

A. Horizontal Bronze Swing Check: Bronze body, bronze mounted, regrinding bronze disc, 150 psi steam rating, 300 psi WOG; Nibco 433-Y.

B. Lead Free Horizontal Bronze Swing Check: Lead Free Silicon Bronze corrosion resistant body, and trim, PTFE renewable seat and disc, 300 psi CWP; NIBCO S/T 413-Y-LF.

C. Horizontal Iron Swing Check: Iron body, bronze mounted, regrinding bronze disc and seat ring, 125 psi rating; Nibco 918.

D. Lead Free Horizontal Iron Swing Check: ASTM A 126 gray Iron body, Stainless steel or Lead Free silicon bronze corrosion resistant trim, 200 CWP psi rating; NIBCO F-918-LF.

2.4 BALL VALVES

A. Bronze Ball: Bronze cast body, chrome-plated full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; Nibco 585-80.

B. Lead Free Bronze Ball: Two piece, full port, Lead Free silicon bronze body, Stainless steel or silicon bronze trim, Reinforced PTFE or TFE seats, 600 psi CWP NIBCO T/S-585-80-LF or T/S-585-66-LF.

C. Bronze Ball, Clean Service: Bronze body, union fittings, bronze ball, self-cleaning, Buna-N ball seats 400 psi WOG factory cleaned, capped and bagged for oxygen service in accordance with CGA4.1 (Cleaning equipment for oxygen service) & NFPA 99, Ohmeda 207 series.

D. PVC Ball: PVC Body, trunion mounted, Teflon seat, Viton seals; True Blue GSR Asahi.

2.5 BUTTERFLY VALVES

A. Ductile iron body, nickel chrome plated disc and stainless steel shaft, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; Nibco 2000, Nibco 4765.

B. Lead Free Butterfly Valve: Ductile iron body, Lead Free Aluminum Bronzedisc and stainless steel stem, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; NIBCO LD- 2000N-3/5,

C. Copper Grooved Piping System Butterfly Valve: Brass body, Aluminum-bronze disc, Fluoroelastomer seat, lever handle, stem length to accommodate insulation, 300 psi water; Victaulic Series 608N.
   1. Grooved ends shall be manufactured to copper-tubing sizes. Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.

2.6 BALANCING VALVE

A. Lead-Free Calibrated:
   1. Bronze, Ametal (copper-alloy), or ductile iron body, brass globe or ball, differential pressure readout valves with integral checks, calibrated plate, integral pointer, suitable for tight shutoff, memory stops, threaded, grooved or soldered ends, 250 psi water, NSF/ANSI 61 compliant, Bell and Gossett Lead-Free Circuit Setter Plus.

2.7 SPECIALTY VALVES

A. Gas Cock: Forged brass body, hard chromium plated forged brass ball, with handle, rubber seats meeting ASTM D471, 175 psi WOG, entire unit tested to latest version of ANSI Z21.15, AGA and UL listed; Wooster, Parker, Watts, Jamesbury, PGL, ASCO.

B. Emergency Gas Shutoff: Cast steel, normally closed, manually opened, electrically held open, automatic closing upon power interruption, Maxon Series CMM11. Provide manual gas cock upstream of emergency gas shut-off valve.

C. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch; Apollo 41 series.

D. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap and chain 3/4 inch size.

E. Gas Pressure Regulator:
   1. Acceptable Manufacturers:
      a. Actaris, Maxitrol, Fisher.
      b. Other Manufacturers: Submit Substitution Request.
   2. Description: 0-500 SCFH capacity at 0-14 inches outlet pressure.
      a. Body: Cast iron complying with ANSI 125 lb. construction standard.
      b. Orifice: Aluminum.
      c. Valve Seat: BUNA-N.
      d. Diaphragm: BUNA-N.
      e. Internal relief valve.
      f. Maxitrol 325 series.
   3. Description: 501-3,000 SCFH capacity at 0-2 PSIG outlet pressure.
      a. Body: Cast iron complying with ANSI 125 lb. construction standard.
      b. Orifice: Brass.
      c. Valve Seat: BUNA-N.
      d. Diaphragm: BUNA-N.
      e. Internal relief valve.
      f. Actaris B38 series.
   4. Description: 3,001-10,000 SCFH capacity at 1-2 PSIG outlet pressure.
      a. Body: Ductile iron.
      b. Orifice: Stainless steel.
      c. Valve Seat: Brass with vulcanized BUNA-N.
      d. Diaphragm: BUNA-N
      e. External relief valve.
      f. Actaris RB1700 series.

2.8 SYSTEM SPECIALTIES

A. Manual Air Vents: Coin type; Dole No. 9 or approved equal.

B. Pressure/Temperature Test Plug:
   1. Acceptable Manufacturers:
      a. Peterson Engineering, Inc., Universal Lancaster, Sisco, Trerice.
      b. Other Manufacturers: Submit Substitution Request.
   2. General: 1/2-inch N.P.T. fitting to receive either a temperature or pressure probe 1/8-inch O.D., fitted with a color coded and marked cap with gasket.
   3. Material: Solid brass with valve core of Nordel.

4. Rating: Minimum 300 psig at 275°F.
5. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch O.D. probe and two five-inch stem pocket test thermometers 25°F to125°F for chilled water, 40°F to 240°F for heating water.

2.9 WATER RELIEF VALVES

A. Acceptable Manufacturers:
   1. Consolidated, Kunkle, B&G, Armstrong, Cash Acme.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Bronze or steel body, stainless steel or bronze, pressure settings to 160 psi at 250°F, conforming to Section IV of ASME Code, size per manufacturer's recommendations based on Code, setting as indicated; Kunkle Model 537.

2.10 STRAINERS

A. Acceptable Manufacturers:
   1. Armstrong, McAlear, Sarco, Steamflo, Mueller, R.P. & C. Company Titan Flow Control.
   2. For Grooved Coupling Systems: Gruvlok or Victaulic.
   3. Other Manufacturers: Submit Substitution Request.

B. Wye Pattern:
   1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.
   2. Ductile Iron: Ductile iron body, 300 psi, 1/16 or 1/8-inch 304 stainless steel screen.
   3. Cast Iron: Cast iron body, 125 psi, 1/16-inch perforated type 304 stainless screen.
   4. Cast Iron, High Pressure: Cast iron body, 250 psi, 1/16-inch perforated type 304 stainless screen.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide valves at connections to equipment where shown or required for equipment isolation.

B. Provide separate support for valves where necessary.

C. Provide drain valves in all low points in the piping system, at coils and equipment, and as indicated.

D. Coordinate gas pressure regulator selection with inlet pressure available at the regulator and the capacity and outlet pressure required by the equipment served. Install in accordance with manufacturer's recommendations. All gas cocks and gas regulator shall be located to be readily accessible for servicing. Provide approved gas cock immediately upstream of each gas pressure regulator. Provide separate vent to the outside for each regulator.

3.2 APPLIED LOCATIONS PLUMBING VALVES

A. In piping 2-inches and smaller:

System	Valve Types				
	Gate	**Globe**	**Swing Check**	**Ball**	**Butterfly**
Domestic Hot	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed
Domestic Cold	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed
Solar Hot Water	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed
Reclaimed Water	Bronze	Bronze	Bronze	Bronze	Not Allowed

B. In piping 2-1/2-inches and larger:

System	Valve Types				
	Gate	**Globe**	**Swing Check**	**Ball**	**Butterfly**
Domestic Hot	Lead Free Iron	Lead Free Iron	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Domestic Cold	Lead Free Iron	Lead Free Iron	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Solar Hot Water	Lead Free Iron	Lead Free Iron	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Reclaimed Water	Iron	Iron	Iron	Not Allowed	Ductile Iron

C. Calibrated balancing valves on domestic hot water. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

D. Silent check valves on pump discharge for domestic cold water, solar hot water and reclaimed water.

E. Check valves on vertical discharge of sump pumps and sewage ejector pumps, iron swing check with outside weight and lever. Mount in piping at 45 degree angle.

F. In Natural Gas Piping:
1. Gas cock.
2. Gas pressure regulator.

G. Provide gauge cock for all pressure gauges.

3.3 VALVE IDENTIFICATION

A. General: Identify valves to indicate their function and system served.

B. See Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.4 CHAIN OPERATORS

A. All valves in equipment rooms or fan rooms used for equipment or coil isolation and more than 8 feet above floor shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6 feet above floor.

3.5 INSTALLATION

A. Manual Air Vents:
1. Install at all high points where automatic air vents are not used, where noted, and where required for proper venting of system.
2. Install in accordance with manufacturer's recommendations.

B. Grooved joints shall be installed in accordance with the manufacturer's published installation instructions. Gaskets shall be molded and produced by the coupling manufacturer, and shall be suitable for the intended service. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the project site to ensure best practices in grooved installation are being followed. (A distributor's representative is not considered qualified to conduct the training of field visits.)

C. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.

D. Water Relief Valves:
   1. Install where indicated, and in accordance with manufacturer's instructions. Pipe discharge to nearest floor drain using Schedule 40 steel pipe.

E. Strainer:
   1. Applied Locations Plumbing:
      a. Bronze wye, in piping 2-inch and smaller; domestic water, solar hot water, reclaimed water.
      b. Cast iron, in piping 2-1/2-inch and larger; solar hot water, reclaimed water.
      c. Cast iron, high pressure wye, in piping 2-1/2-inch and larger; domestic water.

END OF SECTION

HANGERS, SUPPORTS AND ANCHORS FOR PLUMBING

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Supports and anchors for piping systems and equipment.

B. Related Sections include:
   1. Section 22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment.
   2. Section 22 07 00 Insulation for Plumbing.
   3. Section 22 21 13 Pipe and Pipe Fittings Plumbing.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop Drawings of contractor fabricated piping support structures.
   2. No other submittals required under this section.

PART 2 - PRODUCTS

2.1 SUPPORTS, ANCHORAGE AND RESTRAINT

A. General: Provide pipe and equipment hangers and supports in accordance with the following:
   1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
   2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
   3. Seismic restraint shall not introduce excessive stresses in the piping caused by thermal expansion or contraction.
   4. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
   5. Seismic restraints shall be in accordance with the latest edition of the SMACNA “Seismic Restraint Manual - Guidelines for Mechanical Systems” for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
   6. Seismic restraints shall be in accordance with the applicable code.
   7. Seismic restraints shall follow the provisions described in Section 22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment.

B. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.
   1. Supports and seismic restraints for suspended piping and equipment.
   2. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
   3. Equipment and piping support frame anchorage to supporting slab or structure.

2.2 SUPPORTS, GENERAL

A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.

B. Acceptable Manufacturers: Unistrut, Superstrut, Powerstrut and Kinline, B-Line Systems, AnvilStrut.

C. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.

D. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.

E. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.3 PIPE ATTACHMENTS

A. Acceptable Manufacturers: Anvil as noted or equivalent products by Superstrut, B-Line Systems, Tolco, Michigan Hanger.

B. Uninsulated Horizontal Copper Piping:
   1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.
   2. Larger than 2-inch: Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods. Electricians' tape is unacceptable.

C. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.

D. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

E. Other Uninsulated Horizontal Pipe:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

F. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.
   2. Larger than 2-inch: Anvil 260.

G. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

H. Riser Clamps Copper Pipe:
   1. 4-inch and Smaller: Anvil CT-121, CT-121C or 261C.
   2. Larger than 4-inch: Anvil 261C.

I. Riser Clamps Other Piping: Anvil 261.

2.4 PIPE ROLLERS, INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

A. Acceptable Manufacturers: Anvil as noted or equivalent Super Strut, B-Line Systems, Tolco, Michigan Hangers.

B. Pipe Rollers: Anvil 174 or 274 as required. Size for pipe plus insulation for insulated pipe.

C. Insulation Protection Shields: Anvil 167.

D. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory or field copper plated.

2.5 BUILDING ATTACHMENTS

A. Acceptable Manufacturers: Anvil as listed or equivalent products by Elcen, Superstrut, B-Line Systems, Tolco, Michigan Hangers.

B. Beam Hangers:
   1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.
   2. On piping larger than 6-inch: Anvil 228, or 292.

C. Inserts: Anvil 152 malleable iron or 281 steel inserts. Inserts sized for required rod to support load being carried.

D. Expansion Plugs: Similar and equal to Phillips “red-head” self-drilling flush shell selected for safety factor of 4.

E. Powder actuated fasteners with silencers as approved by Architect.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General:
   1. Install all support systems as detailed and in accordance with manufacturer’s recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required and as detailed on the Drawings.
   2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
   3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
   4. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
   5. Install all cast iron piping in accordance with Cast Iron Soil Pipe Industry (CISPI) Standards.
   6. Support all piping within 2 feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:
   1. See Section 22 07 00 for insulation requirements.
   2. Insulated Piping Systems with Vapor Barrier Insulation:
      a. Install hangers outside of insulation.
      b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.
   3. Insulated Piping Systems with Non-Vapor Barrier Insulation:
      a. At the contractor’s option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
      b. If hangers are installed outside of insulation, provide insulation protection shields at all support locations on piping 1-1/2-inch and larger.
      c. On piping larger than 2-inch, provide insulation saddles at each support location.

C. Vertical Piping:
   1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
   2. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
   3. Risers that are not subject to thermal change to be supported at each floor of penetration.
   4. Risers that are subject to thermal change require engineered supports. Size supports to carry all forces exerted by piping system when in operation. Riser supports shall follow the provisions described in Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Horizontal Piping:
   1. Trapeze Hangers: Multiple pipe runs where indicated shall be supported on channels with rust resistant finish. Provide all necessary rods and supporting steel.
   2. Support Spacing: Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:
      a. Support piping within 2 feet of each change in direction.
      b. Steel Pipe, Copper Tubing:

Minimum Pipe Size	Max. Span Steel	Max. Span Copper	Rod Size
1-inch and smaller	7 feet	5 feet	1/4-inch
1-1/4-inch to 2-inch	8 feet	8 feet	3/8-inch
2-1/2-inch to 3-inch	11 feet	9 feet	1/2-inch
4-inch to 5-inch	14 feet	12 feet	1/2-inch
6-inch	17 feet	14 feet	1/2-inch

      c. Plumbing Piping: Support in accordance with local plumbing code.
      d. Plastic Pipe: Supported a maximum of 3 feet on center for piping 1-inch and smaller and 4 feet on center for piping 1-1/4-inch and larger with rod sizes as recommended by the manufacturer.
      e. Piping provided with acoustical lagging wrap shall be supported a maximum of 5 feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:
   1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support all piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
   2. Provide horizontal bracing on all horizontal runs 1-1/2 inch and larger and exceeding 50 feet in length at 75 foot intervals and as required to provide stabilized piping systems.
   3. Provide all additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
   4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Isolation of mechanical equipment as indicated on the Drawings and specified herein.
   2. Seismic restraint of equipment and piping.

B. Related Sections include:
   1. Section 22 05 29 Hangers, Supports and Anchors for Plumbing.

1.3 QUALITY ASSURANCE

A. A single manufacturer shall select and furnish all isolation required, except packaged equipment with integral isolators meeting all the isolation and seismic requirements of this specification.

B. Isolation performance requirements are indicated in the specifications. All deflections indicated are nominal static deflections for specific equipment supported.

1.4 SUBMITTALS

A. Submit the following:
   1. Submit Shop Drawings showing complete details of construction for steel and concrete bases including:
      a. Equipment mounting holes.
      b. Dimensions.
      c. Isolation selected for each support point.
      d. Details of mounting brackets for isolator.
      e. Weight distribution for each isolator.
      f. Code number assigned to each isolator.
   2. Submit product data and calculation sheets for isolators, showing:
      a. Size, type, load rating and rated deflection of each required isolator.
      b. Percent of vibration transmitted based on the lowest disturbing frequency of the equipment.

B. Installation report as specified in Part 3 of this section.

C. Operation and maintenance data.

1.5 EQUIPMENT VIBRATION ISOLATION

A. Provide a balanced set of vibration isolators for each piece of equipment listed in the Equipment Schedules.

B. Isolation work to include, but not necessarily be limited to, the following:
   1. Isolation support of motor-driven equipment.
   2. Inertia base frames in conjunction with isolation.
   3. Isolation support of piping and piping risers.
   4. Penetration isolation of pipework and conduits through walls, floors or ceilings.
   5. Flexible connections of piping to equipment.

C. Each piece of rotating equipment must meet a reasonable criterion for maximum vibration levels at each bearing, while in operation. The criteria for varying operating speeds are given as follows:
   1. Rotating equipment operating peak vibration velocities must not exceed 0.08 in./sec.
   2. If it is discovered that the operating vibration velocities exceed this criteria, the equipment shall be repaired or replaced at no expense to the owner until approval of the equipment is given by the engineer.

D. Any components or materials not specially mentioned herein, but necessary to the proper vibration isolation of the equipment, shall be provided.

1.6 ACCEPTABLE MANUFACTURERS

A. Amber Booth.

B. Mason Industries, Inc.

C. Kinetics Corporation.

D. Vibrex.

E. Approved equal, meeting all of the conditions and requirements specified herein.

1.7 CONTRACTOR RESPONSIBILITY

A. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or suppliers.

B. Adequately restrain all equipment and piping to resist seismic forces. Design and select restraint devices to meet seismic requirements as defined in the latest issue of the International Building Code under Earthquake Design and applicable state and local codes.

C. In addition, the contractor shall have the following responsibilities:
   1. Selection, installation, adjustment and performance of vibration isolators which will meet the requirements given on the plans or in the specifications.
   2. Provide Engineering drawings, details, supervision, and instruction to assure proper installation and performance.
   3. Provide whatever assistance necessary to ensure correct installation and adjustment of the isolators.

PART 2 - PRODUCTS

2.1 TYPE 1 - NEOPRENE WAFFLE PAD

A. 3/4-inch thick neoprene waffle pads with pattern repeating on 1/2-inch centers.

B. Select Duro rating for maximum deflection at average load rating.

C. Include load distribution steel plate as required.

D. Include anchor bolt grommet as required.

E. Acceptable Manufacturer: Mason Type “Super W” or “Super WM” and “HG Grommet”; Similar Amber-Booth, Kinetics Corporation.

2.2 TYPE 2 - RESTRAINED NEOPRENE MOUNT

A. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2-inches and all directional seismic capability.

B. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements.

C. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation.

D. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.

E. Manufacturer: Mason type BR.

2.3 TYPE 3 - SPRINGS

A. Free standing springs without housings.

B. 1/4-inch thick molded neoprene cup with steel reinforcement washer or neoprene acoustical friction pads between base plate and support.

C. All mounting shall have leveling bolts with height saving brackets.

D. Springs mounted outboard of channels.

E. Attach baseplate screws using neoprene bushings and washers.

F. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.

G. Manufacturer: Mason type SLF, Amber-Booth type SW, Kinetics Corporation, Vibrex.

2.4 TYPE 4 - SPRINGS WITH RESTRAINTS

A. Same as springs except housing with seismic restraints to be added.

B. Seismic restraint with molded all directional neoprene bushings an integral part of isolator.

C. Seismic restraint selected for minimum safety factor of 2 from ultimate seismic capacity.

D. Spring mount must have neoprene cup or pad inside the seismic housing to allow anchoring of the housing baseplate without short circuiting pad.

E. Manufacturer: Mason type SSLR or SLRS with seismic restraints; similar Amber-Booth, Kinetics Corporation Model FYS, Vibrex.

2.5 TYPE 5 - BASE WITH SPRINGS

A. Steel Isolating Frame: Mason WFSL with WF steel beams with a minimum depth of 10% of the span between supports. Provide external height saving brackets.

B. Manufacturer: Mason as indicated, similar Amber-Booth, Kinetics Corporation, Vibrex.

2.6 TYPE 6 – INERTIA BASE WITH SPRINGS

A. Inertia Bases: Mason BMK or KSL with 1/2-inch square bar reinforcing, integral height saving brackets and steel templates with anchor bolts sleeves. Bases must be sized to fit stanchions for pump elbows or suction diffusers. Depth of base equal to 8% of the span between supports, 6-inch minimum.

B. Manufacturer: Mason as indicated, similar Amber-Booth, Kinetics Corporation, Vibrex.

2.7 TYPE 7 - ISOLATING SPRING HANGERS

A. Combination rubber-in shear and steel spring isolators installed on the hanger rods.

B. Isolators shall have the proper deflection to allow the piping to deflect as a unit with the pump isolators.

C. Hangers designed for 30 degree angular movement.

D. Minimum deflection shall be one inch.

E. Manufacturer: Mason 30N, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.8 TYPE 8 – ISOLATING NEOPRENE HANGERS

A. Double deflection neoprene hangers shall have a minimum static deflection of 0.35-inches.

B. Provide projecting bushing to prevent steel to steel contact.

C. Manufacturer: Mason HD, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.9 ISOLATING SLEEVES

A. Provided for all piping through walls and floors of penthouses and chiller room. Size for piping as required.

B. Manufacturers: Potter-Roemer PR isolators or Grinnell Semco Trisolators.

2.10 SEISMIC RESTRAINTS

A. General Requirements:
   1. Seismic restraints shall be provided for all equipment and piping, both supported and suspended.
   2. Bracing of piping shall be in accordance with the code and with the provisions set forth in the SMACNA seismic restraint manual.
   3. The structural requirements for the restraints, including their attachment to the building structure, shall be reviewed and approved by the structural engineer.
   4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Supported Equipment:
   1. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.
   2. Bushing shall be replaceable and a minimum of 1/4-inch thick. Rated loadings shall not exceed 1000 psi.
   3. An air gap of 1/4-inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces.
   4. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to ensure no short circuits exist before systems are activated.
   5. Snubber shall be type Z-1225 as manufactured by Mason Industries, Inc.

C. Bracing of Pipes:
   1. Provide seismic bracing of all piping as detailed below to meet the building code requirements:
      a. Exception: Piping suspended by individual hanger's 12-inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be braced where the following criteria are met.
         1) Seismic braces are not required on high deformability piping when the Ip=1.0 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 3-inches diameter or less.
         2) Seismic braces are not required on high deformability piping when the Ip=1.5 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 1-inch diameter or less.
   2. Seismic braces for pipes on trapeze hangers may be used.
   3. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints, or where pipes connect to equipment.
   4. Cast iron pipe of all types, glass pipe, and any other pipe jointed with a shield and clamp assembly, where the top of the pipe is 12-inches or more from the supporting structure, shall be braced on each side of a change in direction of 90 degrees or more. Riser joints on unsupported sections of piping shall be braced or stabilized between floors.

5. Vertical risers shall be laterally supported with a riser clamp at each floor. For buildings greater than six stories high or for piping subject to thermal change all risers shall be engineered individually.

D. Suspended Equipment and Piping:
1. Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
2. Cable must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
3. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.
4. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be type SRC or UC as manufactured by Mason Industries, Inc.
5. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

2.11 FLEXIBLE SPHERE CONNECTOR

A. Flexible EPDM pipe connectors shall be manufactured of multiple plies of Kevlar tire cord fabric and EPDM; both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement.

B. Connectors up to and including 2-inch diameter may have a single sphere and threaded ends. Connectors 2-1/2-inch and larger shall be manufactured with twin spheres up to 12-inches and a single sphere on larger sizes and floating steel flanges recessed to lock the connectors raised face EPDM flanges.

C. All connectors shall be rated a minimum of 150 psi at 220°F. All connections shall be pre-extended as recommended by the manufacturer to prevent additional elongation under pressure.

D. Mason type SFU, SFDEJ or SFEJ.

2.12 FLEXIBLE HOSE CONNECTOR

A. Flexible stainless steel hoses shall be manufactured using type 304 stainless steel hose and braid with one fixed and one floating raised face carbon steel plate flange.

B. Sizes 2-1/2-inch (65mm) and smaller may have threaded male nipples or copper sweat ends. Grooved ends are acceptable in all sizes in grooved piping systems. Weld ends are not acceptable. Copper sweat end hoses for water service shall be all copper or bronze construction.

C. Hose shall have close pitch annular corrugations for maximum flexibility and low stiffness. Tested hose stiffness at various pressures must be included in the submittals.

D. Hose shall be capable of continuous operation at 150 psi and system test pressure when installed in piping systems.

E. Hose shall be the same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required.

F. Mason type BSS, FFL, MN, CPS or CPSB, similar HCi, Metraflex.

2.13 EXPANSION JOINT/SEISMIC CONNECTOR

A. T304 stainless steel hose and braid, Schedule 40 radius elbows and 180 degree bend, flange or weld end Schedule 40 fittings. ASA certified when used for natural gas service. Metraflex Metaloop only.

B. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not install any equipment or pipe which makes rigid contact with the building. "Building" includes slabs, beams, studs, walls, etc.

B. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.

C. Correct, at no additional cost, all installations which are defective in workmanship or materials.

3.2 PREPARATION

A. Treat all isolators, including springs, hardware and housing, with a corrosion protective coating of epoxy powder or electro galvanizing.

B. Coat steel frames exposed to weather with a rustproof metal primer.

C. Provide hot dipped galvanizing on steel frames as indicated on the plans for corrosion protection in severe conditions.

3.3 INSTALLATION

A. General:
   1. Install isolation where indicated on the Drawings by type and location and where indicated below.
   2. The assigned code number shall be marked on the isolators and bases to assure placement in the proper location.
   3. Anchor isolator seismic housing baseplate to floor.
   4. Rubber grommets and washers shall be provided to isolate the bolt from the building structure. Under no circumstances shall the isolation efficiency be destroyed when bolting the isolators to the building structure.

B. Isolating Spring Hangers:
   1. Install on all piping in mechanical rooms connected to rotating equipment. Provide isolating hanger supports for each piece of isolated equipment outside of mechanical rooms and where indicated.
   2. Isolated equipment items in general include air supply units with integral heating or cooling coils, base mounted pumps, line mounted pumps. Air supply units in which fans are internally isolated do not require isolating pipe hangers.

C. Pump Bases:
   1. Provide inertia bases.
   2. Fill with concrete to provide base weight equal to 2 times combined pump, motor, pipe, and water weight.
   3. Support heels of suction and discharge elbows from base.
   4. Secure pump and heel supports with inserts and grout.

D. Flexible Connectors:
   1. Mechanical Couplings: Provide three or more flexible couplings as vibration isolation as indicated on the drawings.
   2. Flexible Sphere Connectors: Provide as indicated on the drawings.
   3. Flexible Hose Connectors: Provide as indicated on the drawings.
   4. Expansion Joint/Seismic Connector: Provide for all piping services where they cross expansion or seismic joints.

3.4 SEISMIC RESTRAINTS

A. General:
   1. Install and adjust seismic restraints so that the equipment and piping support is not degraded by the restraints.
   2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment:
   1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
   2. Care must be taken so that the 1/4-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

C. Bracing of Pipes:
   1. Branch lines may not be used to brace main lines.
   2. Transverse bracing shall be at 40 feet maximum, except where a lesser spacing is indicated in the SMACNA tables for bracing of pipes
   3. Longitudinal bracing shall be at 80 feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity to resist both the seismic load and the additional force induced by expansion and contraction.
   4. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
   5. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24 inches of the elbow or tee.
   6. Subject to confirmation by field inspection, seismic bracing is not required on piping when the piping is supported by rod hangers and the hangers in the entire run are 12-inches or less in length from the top of the pipe to the supporting structure, hangers are detailed to avoid bending of the hangers and their attachments and provisions are made for piping to accommodate expected deflections.

D. Suspended Equipment, Piping, Cable Method:
   1. The cables shall be adjusted to a degree of slackness approved by the Structural Engineer.
   2. The uplift and downward restraint nuts and Mason type RW neoprene covered steel rebound washers for the Type 6 hangers shall be adjusted so that there is a maximum 1/4-inch clearance.

3.5 FIELD QUALITY CONTROL

A. Installation Report: Isolation manufacturer's representative shall confirm that all isolation is installed correctly and submit report stating that isolators are installed as shown on Shop Drawings, isolators are free to work properly, and that installed deflections are as scheduled and as specified.

END OF SECTION

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Identify valves, piping and equipment components of the mechanical systems to indicate their function and system served.

1.3 SUBMITTALS

A. Submit the following:
   1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
   2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
   3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 - PRODUCTS

2.1 VALVE IDENTIFICATION

A. Valve Tags:
   1. General: Identify valves with metal tags, legends to be stamped or embossed. It shall indicate the function of the valve and its normal operating position; i.e.,

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)

   2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
   3. Material: Use 0.050 or 0.064-inch brass tags.
   4. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, “lamicoid” or equal. Form letters by exposing center ply.

B. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.2 PIPING MARKERS

A. Acceptable Manufacturers:
   1. W.H. Brady, Seton, Marking Systems, Inc. (MSI).
   2. Other Manufacturers: Submit Substitution Request.

B. Pipes shall be labeled with all-vinyl, self-sticking labels or letters. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters. The pipe markers shall be identified and color coded as follows with black directional arrows.

PLUMBING SERVICE	BACKGROUND PIPE MARKER *	COLOR
COLD WATER	“DOMESTIC COLD WATER”	GREEN
HOT WATER	“DOMESTIC HOT WATER SUPPLY”	YELLOW
	“DOM. HOT WATER RECIRC”	YELLOW OR GREEN
SANITARY WASTE	“SANITARY WASTE”	GREEN
STORM DRAIN	“STORM DRAIN”	GREEN
OVERFLOW DRAIN	“OVERFLOW DRAIN”	GREEN
VENT	“VENT”	GREEN
NATURAL GAS	“NATURAL GAS”	YELLOW
NATURAL GAS VENT	“NATURAL GAS VENT”	YELLOW
RECLAIMED WATER	“CAUTION: RECLAIMED WATER, DO NOT DRINK”	PURPLE
SOLAR HOT WATER	“SOLAR HOT WATER SUPPLY”	YELLOW
	“SOLAR HOT WATER RETURN”	YELLOW

* Directional arrow applied adjacent to pipe marker indicating direction of flow.

** Provide custom marker labels for all piping for which no standard manufactured marker is available. Submit sample for approval.

C. Reclaimed Water:
   1. All reclaimed water pipe and fittings shall be continuously wrapped with purple-colored Mylar tape over insulation, with the words "CAUTION: RECLAIMED WATER, DO NOT DRINK". The lettering shall be imprinted in two (2) parallel lines, such that after wrapping the pipe with a one-half (1/2) width overlap, one (1) full line of text shall be visible.
   2. Wrapping tape is not required for buried PVC pipe manufactured with purple color integral to the plastic and marked on opposite sides to read "CAUTION: RECLAIMED WATER, DO NOT DRINK" in intervals not to exceed three (3) feet (914 mm).
   3. Outlets and fixtures served with harvester rainwater shall be easily recognizable by color or symbol for non-potable water.

2.3 EQUIPMENT IDENTIFICATION

A. Nameplates:
   1. Tag all pumps, converters, and miscellaneous items of mechanical equipment with engraved nameplates. Nameplates shall be 1/16-inch thick, 3 x 5 laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
   2. Identify unit with code number as shown on Drawings and area served.

B. Equipment Nameplate Directory: List pumps, and other equipment nameplates. Include Owner and Contractor furnished equipment. List nameplate designation, manufacturer’s model number, location of equipment, area served or function, disconnect location, and normal position of HOA switch.

PART 3 - EXECUTION

3.1 VALVE IDENTIFICATION

A. Valve Tags:
   1. Attach to valve with a brass chain.
   2. Valve tag numbers shall be continuous throughout the building for each system. Contractor shall obtain a list for each system involved from the owner to establish numbers following the listed sequences:

B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.2 PIPING MARKERS

A. Unless recommendations of ANSI A13.1, 1981 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
   1. Every 20 feet along continuous exposed lines.
   2. Every 10 feet along continuous concealed lines.
   3. Adjacent to each valve and stubout for future.
   4. Where pipe passes through a wall, into and out of concealed spaces.
   5. On each riser.
   6. On each leg of a “T”.
   7. Locate conspicuously where visible.
   8. Provide pipe identification (over insulation) for all reclaimed water systems in accordance with current local codes and rulings.

B. Further, apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

C. Install tags on specialty gas piping valves with brass chain.

3.3 EQUIPMENT IDENTIFICATION

A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

END OF SECTION

PRESSURE TESTING FOR PLUMBING SYSTEMS

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Pressure testing of piping systems.

1.3 QUALITY ASSURANCE

A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.

B. Owner Witness: Perform all tests in the presence of the Owner's representative.

C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe all tests or selected tests to assure compliance with the specifications.

D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's representative and the Engineer's representative need not occur simultaneously.

1.4 SUBMITTALS

A. Submit the following:
   1. Test Reports:
      a. Submit certificate of completion, inspection and test by authority having jurisdiction on required piping systems.
      b. Submit certificate of test approval by Owner's representative on all systems.
      c. The Engineer's representative will record witnessed tests.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL

A. Piping: Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties. Conduct tests with all valves but those used to isolate the test section 10% closed.

B. Leaks: Repair all leaks and retest until stipulated results are achieved.

C. Notification: Advise the Architect 72 hours in advance of each test. Failure to so notify will require test to be rescheduled.

D. Testing Equipment: Provide all necessary pumps, gauges, connections and similar items required to perform the tests.

3.2 TESTING REQUIREMENTS

A. Sanitary and Roof Drainage Systems: Test entire system or sections of system by closing all openings in piping except highest opening and filling system with water to point of overflow. If system is tested in sections, plug each opening except highest opening of section under test and fill each section with water, but none with less than l0-feet head of water. Keep water in system or in portions under test for at least 45 minutes before inspection starts. Test for two (2) hours with no drop allowed. Locate and repair leaks.

B. Domestic and Reclaimed Water Systems: Test per current State and local codes.

C. Piping - General: Test all piping as noted below, with no leaks or loss in pressure for time indicated. Repair or replace defective piping until tests are completed successfully:

Plumbing Systems	Test Pressure	Test Medium	Test Duration
Natural gas piping	60 psig	Air	4 hours

END OF SECTION

TESTING, ADJUSTING AND BALANCING FOR PLUMBING

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 provisions of Section 22 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Testing and balancing of domestic hot water recirculation systems.
   2. Testing and balancing of pumping systems.

B. Related Sections include:
   1. Section 22 08 00 Commissioning for Plumbing HVAC.

1.3 QUALITY ASSURANCE

A. Acceptable Testing and Balancing Firms:
   1. A.I.R., Inc.
   2. Air Balance Specialty, Inc.
   3. Neudorfer Engineers, Inc.
   4. Northwest Engineering Services.
   5. Pacific Coast Air Balance.
   6. Accurate Balancing Agency, Inc.

B. Other Firms: Submit Substitution Requests prior to Bid Date.

C. Industrial Standards: Testing and Balancing shall conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
   1. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
   2. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
   3. ANSI:
      a. S1.4 Specifications for sound level meters.
      b. S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.

D. Instrument Certification: All instruments used shall be accurately calibrated and certified within six months of balancing and maintained in good working order.

E. Test Observation: If requested, the tests shall be conducted in the presence of the Architect or the Architect’s representative.

F. Pre-Balancing Conference: Prior to starting balancing, general techniques shall be reviewed with the Engineer. This conference must occur prior to measuring existing conditions. Measuring of existing conditions must occur prior to any demolition or new work. The conference will review existing conditions and systems to be affected by the project

1.4 SUBMITTALS

A. Submit the following:
   1. Balancing Log: Include all water outlets, actual field measured water volume, and percentage of design volumes. Provide drawings identifying location of all outlets.
   2. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
   3. Additional Data: Submit all additional data as provided by Associated Air Balance Council (AABC) Standard forms.
   4. Number of Copies: Submit six (6) copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
   5. Instrument Certification: When requested, submit certificate of calibration for all equipment to be used.

B. Record data on NEBB forms or forms approved by the Architect.

1.5 PROJECT CONDITIONS

A. Do not perform final testing, adjusting, and balancing work until equipment has been completely installed and operating continuously as required.

B. Conduct testing and balancing with clean strainers and filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.6 WARRANTIES

A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER RECIRCULATION SYSTEMS

A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
   1. List complete data of tested equipment and verify against Contract Documents.
   2. Open all line valves to full open position.
   3. Set master mixing valve as described by manufacturer’s recommendations to achieve desired leaving water temperature.
   4. For each pump:
      a. Verify rotation.
      b. Test and record pump shut-off head.
      c. Test and record pump wide-open head.
   5. Verify proper system pressures.

C. Distribution:
   1. Read and adjust water flow for design conditions.
   2. Set all memory stops and mark position of adjuster on balancing valves.

3.2 DOMESTIC HOT WATER POINT OF USE MIXING VALVES

A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
   1. List complete data of tested equipment and verify against Contract Documents.
   2. Open all line valves to full open position.

C. Distribution:
   1. Adjust water flow for design conditions.
   2. Set mixing valve to achieve desired leaving water temperature.
   3. Set all memory stops and mark position of adjuster on balancing valves.

3.3 AUTOMATIC CONTROL SYSTEM

A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Testing organization shall verify all controls for proper calibration and list controls requiring adjustment by control system installer.

3.4 COORDINATION

A. Coordinate work with other trades to ensure rapid completion of the project.

B. Deficiencies noted during the course of balancing in the mechanical installation shall be promptly reported to the Architect to allow corrective action to proceed.

C. Periodic review of progress shall be provided as requested.

END OF SECTION

INSULATION FOR PLUMBING

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Insulation for piping, and equipment.

B. Related Sections include:
   1. Section 22 05 29 Hangers, Supports and Anchors for Plumbing.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All insulating products shall comply with the Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
   2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723.
   3. Energy Codes: Local Building and Energy Codes shall govern where insulation performance requirements for thickness exceeds thickness specified.

B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.

C. Source Quality Control:
   1. Service: Use insulation specifically manufactured for service specified.
   2. Labeling: Insulation labeled or stamped with brand name and number.
   3. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping, or ductwork, and shall be asbestos free.

1.4 SUBMITTALS

A. Submit the following.
   1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Equivalent products by Johns Manville, Knauf, Owens Corning, and CertainTeed are acceptable.

B. All such insulation shall be of one manufacturer.

C. Other Manufacturers: Submit Substitution Request.

2.2 PIPE INSULATION

A. Fiberglass: Split sectional or snap-on type with 0.23 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature, 850°F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system. Johns Manville Microlok HP.

B. Calcium Silicate: Sectional with 14 pcf nominal density, 0.40 maximum K-factor at 300°F mean temperature and 1200°F maximum service rating. Johns Manville Thermo-12 Gold.

C. Elastomeric: Expanded closed cell, 0.27 per inch maximum K-factor at 75°F mean temperature, 220°F maximum service rating with fitting covers and paintable surface. Armacell AP Armaflex, Rubatex.

D. Polyolefin: Semi-rigid polyolefin form snap-on or slip over type with 0.24 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature -165°F to 210°F service factor and paintable surface. End joints in insulation on piping with fluid temperatures normally below 65°F fuse sealed in accordance with the manufacturer's instructions. Joints longitudinal joints and other end joints made with manufacturer's approval contact adhesive in accordance with the manufacturer's instructions. Joints may be pre-glued or pre-coated with adhesive where applicable.

2.3 BLOCK INSULATION

A. Fiberglass: 1-1/2-inch thick unless specified or shown otherwise with 3 pcf nominal density, 0.23 per inch maximum K-factor at 75°F mean temperature and 450°F minimum operating temperature limit. Johns Manville 1000 Series.

2.4 ACCESSORIES PIPING

A. Adhesives:
   1. Fiberglass: Zeston Z-Glu.
   2. Calcium Silicate: Benjamin Foster 30-36.
   3. Elastomeric: Armacell 520.
   4. Polyolefin: As approved by the insulation manufacturer.

B. Cements:
   1. Insulating: Ryder.
   2. Heat Transfer: Zeston Z-20.

C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.

E. Grooved Coupling Insulation: One piece PVC insulated fitting cover, Zeston, Ceel-Co.

F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.

G. Cloth Facing: Presized fiberglass cloth.

H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.

I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship:
   1. Installation: Insulation installed in first class, neat professional manner.
   2. Applicators: Applicators shall be employed by firm that specializes in insulation work.

B. Preparation: Surfaces of piping and equipment clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels shall not be covered.

3.2 PLUMBING PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – Plumbing Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Domestic Cold Water, Above Grade	1 1/4-inch and smaller	Fiberglass, all purpose jacket or Elastomeric or Polyolefin	1-inch	Note 1 Note 2
	Above 1 1/4-inch	Fiberglass, all purpose jacket	1 1/2-inch	Note 1
Non-Potable Cold Water, Above Grade	1 1/4-inch and smaller	Fiberglass, all purpose jacket or Elastomeric or Polyolefin	1-inch	Note 1 Note 2
	Above 1 1/4-inch	Fiberglass, all purpose jacket	1 1/2-inch	Note 1
Reclaimed Water, Above Grade	1 1/4-inch and smaller	Fiberglass, all purpose jacket or Elastomeric or Polyolefin	1-inch	Note 1 Note 2
	Above 1 1/4-inch	Fiberglass, all purpose jacket	1 1/2-inch	Note 1
Domestic Hot Water Supply/Return, Above Grade	1 1/2-inch and smaller	Fiberglass, all purpose jacket or Elastomeric or Polyolefin	1 1/2-inch	Note 1 Note 2
	Above 1 1/2-inch	Fiberglass, all purpose jacket	2-inch	Note 1
Solar Hot Water	1 1/2-inch and smaller	Fiberglass, all purpose jacket or Elastomeric or Polyolefin	1 1/2-inch	Note 1 Note 2
	Above 1 1/2-inch	Fiberglass, all purpose jacket	2-inch	Note 1
Interior Storm Drain and Interior Overflow Drains	All	Fiberglass, all purpose jacket	1/2-inch	Note 3
Traps and trap priming lines (In unheated Spaces)	All	Fiberglass, all purpose jacket	1-inch	Insulate over heat tape
Condensate or other cold water drains	All	Elastomeric or Polyolefin	1/2-inch	Note 2
Note 1: Cover with metal pipe jacket where exposed to weather, and over heat trace cable. Note 2: Elastomeric or polyolefin insulation not allowed over heat trace cable. Note 3: Drain bodies, insulate the first 10 feet connected to the drain body, and all horizontal piping. Do not insulate main vertical stack.				

B. The following piping is not insulated:
   1. Waste and vent, except where heat traced.
   2. Natural gas.
   3. Domestic cold water runouts to single fixture less than 12-inch long and exposed supplies.
   4. Priming lines except where heat traced.

C. Insulation shall include all fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves, except valve bonnets, unions and flanges need not be insulated on the following systems: Domestic and solar hot water, inside building.

D. Valves and irregular fittings shall be insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 oz. canvas and Foster 30-36 lagging adhesive. The contractor shall have the option on all flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 oz. glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge S.S. lacing wire.

E. Expansion Joints and Flexible Connectors: Pipe insulation or block of same material and thickness as adjacent piping.

3.3 PIPING INSTALLATION

A. General:
   1. Joints: Coat both sides of complete joining area with applicable adhesive.
      a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
      b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
      c. Multiple Layered Insulation: Joints staggered.
   2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
   3. Voids: Fill all voids, chipped corners and other openings with insulating cement or material compatible with insulating material. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
   4. Seal joints, seams and fittings of metal watertight jackets at exterior locations.

B. Fiberglass Insulation: Exterior insulation encased in metal jacket.

C. Calcium Silicate Insulation:
   1. Secure with 18-gauge wire embedded into insulation.
   2. Cover with continuous vapor barrier jacket.

D. Elastomeric and Polyolefin Insulation:
   1. Slit full length and snap around pipe.
   2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
   3. Do not stretch insulation to cover joints or fittings.
   4. Seal joints in elastomeric insulation with adhesive.
   5. Seal joints in polyolefin as specified hereinbefore.
   6. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer’s instructions and encase in metal jacket.
   7. Sealing joints with tape will not be allowed.

E. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
   1. On Elastomeric and Polyolefin Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
   2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

F. Unions, Mechanical Joints, Valves, Etc.:
   1. General:
      a. As specified for fittings.
      b. Minimum thickness same as specified for piping.
   2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
   3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
   4. Flanged Valves: Insulation with square corners.

G. Vapor Barrier Insulation:
   1. Refer to Section 22 05 29 for support requirements.
   2. Piping which requires vapor barrier protection shall have a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
      a. Domestic cold water.
      b. Industrial cold water.
      c. Non-potable cold water.
      d. All other piping systems with a nominal operating temperature below 65°F.
   3. Vapor Barrier Insulation:
      a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
      b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 22 05 29.

H. Non-Vapor Barrier Insulation:
   1. Refer to Section 22 05 29 for support requirements.
   2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
   3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
   4. Void between saddle and pipe filled with insulation.

3.4 EQUIPMENT INSTALLATION

A. General: Install true and smooth. Insulation over curved surfaces shall conform to curves of surface.
   1. Access: Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance shall be provided with covers or section that are easily removable and replaceable. Reinforce openings in adjacent insulation with metal beading. In vapor barriered insulation, coat joints with vapor barrier mastic.
   2. Voids, Depressions and Cavities: All voids, chipped corners and other openings shall be filled with insulating cement or material compatible with insulating material.
   3. Vapor Barriered Insulation: Where insulation is specified to have a vapor barrier, the barrier shall not be pierced or broken.
      a. Tears, etc., shall be coated with vapor barrier mastic and patched with insulation facing or tape.
      b. Staples brush coated with vapor barrier coating.
      c. All raw edges coated with vapor barrier mastic shall be covered and cover shall be sealed to equipment surface.
   4. Non-Vapor Barriered Insulation:
      a. Tears, etc., shall be patched with insulation facing or tape.
      b. All raw edges shall be covered and neatly beveled to the equipment surface.
   5. Multilayered Insulation: With staggered joints.

B. Fiberglass Block:
   1. Anchors: Lug nuts 10 gauge black annealed iron wire welded to metal surfaces.
   2. Banding: Block secured to surface with 1/2-inch wide stainless steel bands maximum 18-inches on center and secured to anchors.

3. Insulating Cement: Block covered with insulating cement minimum thickness of 1/2-inch with smooth finish.
4. Vapor Barriered System: On vapor barriered system, apply continuous coat of vapor barrier mastic.
5. Finish: Finish with cloth facing secured with adhesive and lapped a minimum of 2 inches. Defects touched up with finishing cement.

C. Elastomeric Blanket: Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.

D. Expansion Joints: Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system and finished with cloth facing cemented to insulation with adhesive.

E. Heat Exchangers: Insulation thickness and material as specified for piping and applicable service.

3.5 FIELD QUALITY CONTROL

A. Field Test: All systems shall be tested and approved prior to installation of insulation.

END OF SECTION

COMMISSIONING FOR PLUMBING

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

C. The Work of this Section is supplemental to and does not supersede any other requirements of the Contract Documents.

1.2 SUMMARY

A. The commissioning process is described in Section 01 91 13 General Commissioning Requirements.

B. Provide all labor and materials required to complete the commissioning of those Division 22 systems and equipment identified as Commissioned Systems and Equipment in Section 01 91 13 General Commissioning.

C. Related Sections include:
   1. Section 01 91 13 General Commissioning Requirements.
   2. All Sections of Division 22.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.4 COMMISSIONING SCOPE OF WORK - COMMISSIONING AGENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.5 COMMISSIONING SCOPE OF WORK - CONTRACTOR

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 3 - EXECUTION

3.1 MEETINGS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.2 INSTALLATION, CHECK-OUT, START-UP AND PREFUNCTIONAL CHECKS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.3 FUNCTIONAL TESTING

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.4 TRAINING OF FACILITY OPERATING STAFF AND BUILDING OCCUPANTS

A. Refer to Section 01 91 13 General Commissioning Requirements.

END OF SECTION

PIPE AND PIPE FITTINGS PLUMBING

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Furnish piping, pipe fittings, and incidental related items as required for complete piping systems.

B. Related Sections Include:
   1. Section 22 25 00 Plumbing Water Treatment.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Piping material and installation to meet requirements of the local plumbing, fire, and building codes and serving utility requirements.
   2. Provide chlorination of domestic cold and hot water piping in accordance with County and State health requirements.

B. All grooved joint couplings and fittings shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

C. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, reclean, and reconnect without additional expense to the Owner.

D. Correct any damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

E. All products with a wetted surface installed in potable water systems shall be UL classified in accordance with ANSI / NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.

1.4 SUBMITTALS

A. Submit the Following:
   1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).
   2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.

B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

C. Other: Make certified welders' certificates available.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As indicated.

2.2 CAST IRON SOIL PIPE, SERVICE WEIGHT (NO-HUB)

A. General: A code approved hubless system conforming to Cast Iron Soil Pipe Institute Standard 301.

B. Pipe and Fittings: Service weight hubless cast iron conforming to ASTM A 74, marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International. Tyler, AB&I, or Charlotte.

C. Gaskets: Compression type conforming to ASTM C 564.

D. Couplings:
   1. Above Grade: Band type coupling in conformance with Cast Iron Soil Pipe Institute (CISPI) 310-90, consisting of stainless steel clamp and corrugated shield assemblies with a neoprene sealing sleeve ANSI A21.6, ANSI A21.10 Fittings.
   2. Buried: Husky 28 gauge 304 stainless steel hubless type clamp and orange corrugated shield assemblies (80-inch pound torque) with neoprene sealing gaskets (ASTM-C-564), or Clamp-All (125-inch pound torque), 24 gauge 304 stainless steel hubless type clamp, and shield assemblies with neoprene sealing gaskets (ASTM-C-564).

E. Service:
   1. Sanitary, storm, and overflow drain.
   2. Vent piping 2 inches and above.

2.3 DUCTILE IRON WATER PIPE

A. Pipe: Ductile iron pipe conforming to ANSI A21.51.

B. Fittings: Below grade, Class 150 “Boltite” mechanical joint type complete with gaskets, bolts, and nuts, or “Tyton” for joints employing a single gasket for the joint seal with bell-and-spigot pipe. Above grade, mechanical couplings and fittings as specified herein. Provide interior pipe coating per ANSI Regulation listed.

C. Service:
   1. Below grade, incoming domestic water main, 4 inches and over.
   2. Above grade, domestic water piping, 6 inches and over.

2.4 BLACK STEEL PIPE, SCHEDULE 40

A. General: Fittings and joints must be UL listed for use with pipe chosen for use. Listing restrictions and installation procedures per state and local authorities must be followed.

B. Pipe: Schedule 40 conforming to ASTM A 135 or A 53.

C. Fittings: 150 lb. screwed malleable iron on 2 inches and below, Schedule 40 welding fittings conforming to ASTM A 234 for 2-1/2 inches and above or mechanical couplings on select piping as herein specified. Fittings below grade shall be welding fittings. All elbows on pumped systems shall be long radius type. Short radius elbows not acceptable for use except as approved on a case by case basis.

D. Service:
   1. Compressed air piping, except medical compressed air.
   2. Natural gas piping and vent lines.
   3. Fuel oil piping, above grade. Piping concealed in walls shall be socket welded.
   4. Fuel oil vent, fill, and gauge.

2.5 GALVANIZED STEEL PIPE

A. Pipe: Schedule 40 conforming to ASTM A 135 or A 53.

B. Fittings: 150 lb. screwed galvanized malleable iron on 2-inch and below, Victaulic, Gruvlok, Gustin-Bacon, or Mech Line full flow galvanized, grooved end on 2-1/2-inch and above. Provide grooved type gasketed couplings and fittings for pipe 2-1/2-inch and above.

C. Service:
   1. Miscellaneous indirect waste piping.
   2. At Contractor's option, waste and vent piping 1-1/2 inches and under, above grade.
   3. Pumped waste (above grade only).

2.6 COPPER PIPE

A. Pipe: Hard drawn copper tubing, Class L or K, ASTM B 88.

B. Fittings: Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal. At contractor's option, a system using mechanically extracted collars in main with branch line inserted to not obstruct flow may be used on domestic water piping above ground, similar to T-drill.

C. Service:
   1. Domestic hot and cold water piping below ground (Type K, hard drawn) on piping 3 inches and smaller.
   2. Domestic hot and cold water piping above ground (Type L, hard drawn) on piping 4 inches and smaller.
   3. Trap priming lines (Type L, annealed).
   4. Pumped waste (DWV).
   5. Reclaimed water.
   6. Solar hot water.
   7. Miscellaneous drains and overflows.

2.7 CPVC PIPE

A. Pipe: Manufactured to ASTM F 2618 specifications for CPVC pipe and fittings for Chemical Waste Drainage and produced in ASTIM D 3311 drainage patterns. Pipe shall be certified NSF International for use with corrosive waste water. Spears Manufacturing "LabWaste" pipe or equal.

B. Fittings: Manufactured to ASTM F 2618 specifications for CPVC pipe and fittings for Chemical Waste Drainage and produced in ASTIM D 3311 drainage patterns. Spears Manufacturing "LabWaste" fittings or equal.

C. Solvent Cement: For CPVC pipe conforming to the requirements of ASTM F493. Solvent cement shall be certified by NSF International for use with corrosive waste water.

D. Service: Acid waste and vent.

2.8 POLYETHYLENE PIPE

A. Pipe: Polyethylene pipe and tube PE 3406 conforming to ASTM D2513-80a.

B. Fittings: Provide copper alloy, PE 3306, PE 3406, stainless steel or other listed materials. Mechanical connectors for PE pipe and tubing and for transition fittings shall be approved compression type couplings or other special listed joints.

C. Storage: Do not store unprotected pipe in direct sunlight. Store in a way to protect it from mechanical damage.

D. Service: Buried natural gas piping.

2.9 PVC PIPE (DWV)

A. Pipe: PVC, wall thickness equal to Schedule 40 standard steel pipe, conforming to ASTM D2665-85a.

B. Fittings: PVC building drain, waste, and vent fittings conforming to ASTM D2665-85 and ASTM D3311-82.

C. Solvent Cement: For PVC pipe conforming to ASTM D2564-80.

D. Service: Sanitary waste and vent, except not allowed in return air plenums, and below grade.

2.10 ABS PIPE (DWV)

A. Pipe: ABS, wall thickness equal to schedule 40 standard steel pipe, conforming to ASTM D2661-85a.

B. Fittings: ABS waste and vent fittings conforming to ASTM D2661-85a and ASTM D3311-82.

C. Solvent Cement: For ABS pipe conforming to the requirement of ASTM D2235-81.

D. Service: Sanitary waste and vent, storm and overflow, except not allowed in return air plenums.

2.11 PEX POTABLE WATER TUBING

A. Acceptable Manufacturers:
   1. Wirsbro/Uponor, Nibco, Watts.
   2. Other Manufacturers: Submit Substitution Request.

B. Regulatory Listings: Submit appropriate NSF International, UL, Warnock Hesey or CSA listings as proof of compliance with local building and plumbing codes.

C. PEX tubing and components shall be installed in full compliance with all local jurisdictional codes, standards and requirements.

D. Submit listings that indicated that the PEX tubing system has been certified to ANSI/NSF Standards 14 and 61.

E. Quality Assurance:
   1. Installer Qualifications: Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.
   2. Installer shall provide in writing to the Owner that the PEX tubing and components furnished under this Section conforms to the material and mechanical requirements specified herein.

F. Materials:
   1. Tube Materials: Tube shall be cross-linked polyethylene (PEX) manufactured by PEX-A or peroxide method. Provide “blue” colored PEX for cold water systems and “red” colored PEX for hot water systems.
   2. Tubing Type: PEX tubing shall be manufactured in accordance with ASTM F876, ASTM F877 and CAN/CDA-B137.5. The tube shall be listed to ASTM by an independent third party agency.
      a. PEX tubing shall have Standard Grade hydrostatic design and pressure ratings of 200°F at 80 psi and 180°F at 100 psi. Temperature and pressure ratings shall be issued by the Plastic Pipe Institute (PPI).
      b. Minimum bend radius for cold bending of the PEX tubing shall not be less than 6 times the outside diameter. Bends with the radius less than stated shall require the use of a bend support as supplied by tube manufacturer.
   3. Manifold Type: Wirsbro Type “L” Q-Series copper manifold with integral valves.
   4. Fittings: Fittings shall be brass. Fittings shall be PEX-A cold expansion type fitting. Wirsbro ProPEX fittings.
      a. Fittings shall be supplied by the PEX tubing manufacturer.
      b. PEX fittings shall be manufactured in accordance with ASTM F1960. The fittings shall be listed to ASTM by an independent third party agency.
      c. PEX-A cold expansion type fittings shall be an assembly consisting of insert and PEX-A cold expansion ring.

G. Accessories:
   1. Wall Penetration Brackets: Brackets designed for wall membrane penetrations shall be supplied by PEX tubing manufacturer; Wirsbro Drop Ear Bend Support.
   2. Concrete Tube Support Brackets: Brackets to hold PEX tubing in place in structural concrete slabs shall be of rigid PVC construction and be designed for that purpose.
   3. Wirsbro “Stand-Up” bracket.

H. Service: Domestic cold and hot water supply drops to individual lavatories, sinks, tank type toilets and to the shower mixing valves. PEX tubing shall not serve any fixtures with fast closing valves (flush valves, solenoid valves, etc.) and shall not be used downstream of the shower mixing valve. Domestic water piping distribution systems serving PEX manifolds shall be copper.

2.12 FLANGED JOINTS

A. Flanged Joints: Flanges shall be cast iron or steel for screwed piping and forged steel welding neck for welded line sizes. Pressure rating and drilling shall match the apparatus, valve, or fitting to which they are attached. Flanges shall be in accordance with ANSI B16.1; 150 lb. for system pressures to 150 psig; 300 lb. for system pressures 150 psig to 400 psig. Gaskets for all flanged services, except steam and pumped condensate, shall be Garlock 3700 or equal, 1/8-inch thick, non-metallic type. Gaskets for steam and pumped condensate shall be Flexitaulic Style CG or equal, 1/8-inch thick, semi-metallic type. Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nuts (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig. Use length of bolt required for full nut engagement. Provide electro-cad plated bolts and nuts on cold and chilled water lines.

2.13 UNIONS

A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.
   1. Unions or flanges for servicing or disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points.)

B. Dielectric fittings shall be nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F-492. Fittings shall be suitable for the pressure and temperature to be encountered.

2.14 SOLDER AND BRAZING

A. Brazed Joints:
   1. Wrought Copper Piping Fittings: Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
   2. Applied locations:
      a. All below grade piping.
      b. All above grade piping larger than 2-inches for the following services: Industrial cold water, domestic hot and cold water, and pumped waste.
      c. Oxygen, nitrous oxide, carbon dioxide, medical vacuum, lab vacuum and lab air. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
      d. Joints in Domestic Hot and Cold Water Piping: Use mechanically extracted collars. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
      e. Solar hot water.

B. Soldered Joints:
   1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
   2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
   3. Applied locations: Above grade piping 2-inch and smaller for the following services: Industrial cold water, domestic hot and cold water, pumped waste, trap priming lines.

2.15 UTILITY MARKERS

A. Provide plastic tape utility markers over all buried piping. Provide identification on tape.

B. Material to be Brady Identoline plastic tape, 6-inch, Seton, or as approved.

2.16 PIPE WRAPPING

A. For all below ground steel piping and fittings, provide complete covering of Scotchrap No. 51, 20 mil thickness, protective tape applied over Scotchrap pipe primer applied at 1 gal/800 SF of pipe surface.

B. At Contractor's option as approved, pipe may be furnished with factory applied jacket of "X-tru-coat" with Scotchrap as previously specified for field joints.

2.17 FLEXIBLE CONNECTOR

A. Expansion Joint/Seismic Connector:
   1. T304 stainless steel hose and braid, Schedule 40 radius elbows and 180° bend, flange or weld end Schedule 40 fittings. ASA certified when used for natural gas service. Metraflex Metaloop only.
   2. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.
   3. In steel piping systems, three Victaulic flexible couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief at equipment connections. The couplings shall be placed in close proximity to the vibration source.

B. Service:
   1. Natural gas piping and vent lines.
   2. Miscellaneous drains and overflows.
   3. Domestic hot and cold water piping.

2.18 ABS DWV EXPANSION JOINT

A. Expansion Joint:
   1. DWV expansion/compression joint made from ABS. Certified by NSF International. UPC approved. Canplas, Fernco, or no-hub coupling per 22 21 13-2.02-D with ABS adaptors approved by AHJ.
   2. See ABS Pipe (DWV) piping specifications for required pressure and temperature rating.

B. Service:
   1. Sanitary waste and vent as indicated on drawings, storm and overflow piping above grade.
   2. Storm and overflow piping: install joint at every floor level on each riser.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measurements, Lines and Levels:
   1. Check dimension at the building site and establish lines and levels for work specified in this Section.
   2. Establish all inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
   3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.2 EXCAVATION AND BACKFILL

A. General: Perform all necessary excavation and backfill required for the installation of mechanical work in accord with Division 31. Repair pipelines or other work damaged during excavation and backfilling.

B. Excavation: Excavate trenches to the necessary depth and width, removing rocks, roots, and stumps. Include additional excavation to facilitate utility crossovers, additional offsets, etc. Excavation material is unclassified. Width of trench shall be adequate for proper installation of piping. The trench shall be widened, if not wide enough for a proper installation.

C. Bedding: All cast iron, steel, and copper piping shall be full bedded on sand. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose. Remove the sand to the necessary depth for piping bells and couplings to maintain contact of the pipe on the sand for its entire length. Lay all other piping on a smooth level trench bottom so that contact is made for its entire length.

D. Backfill: Place in layers not exceeding 8 inches deep, and compact to 95% of standard proctor maximum density at optimum moisture content. Earth backfill shall be free of rocks over 2 inches in diameter and foreign matter. Disposal of excess material as directed.
   1. Interior: All backfill under interior slabs shall be bank sand or pea gravel.
   2. Exterior: Excavated material may be used outside of buildings at the Contractor's option. The first 4 inches shall be sand, and final 12-inch layer course shall be soil in any event.

3.3 PIPING INSTALLATION

A. Install unions in all non-flanged piping connections to apparatus and adjacent to all screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.

B. Mechanical Pipe Couplings and Fittings:
   1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   2. Flexible couplings to be used only when expansion, contraction, deflection or noise and vibration is to be dampened, as detailed or specified.
   3. On systems using galvanized pipe and fittings, fittings shall be galvanized at factory.
   4. Before assembly of couplings, lightly coat pipe ends and outside of gaskets with approved lubricant.
   5. Pipe grooving in accordance with manufacturer's specifications contained in latest published literature.
   6. Gaskets shall be molded and produced by the coupling manufacturer, and shall be suitable for the intended service.
   7. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the project site to ensure best practices in grooved installation are being followed. (A distributor's representative is not considered qualified to conduct the training or field visits.)

C. Install all piping as to vent and drain. Install according to manufacturer's recommendations.

D. Support all piping independently at apparatus so that its weight shall not be carried by the equipment.

E. Run piping clear of tube cleaning or removal/replacement access area on heat exchangers, water heaters, etc.

F. Utility Marking: Installed over the entire length of the underground piping utilities. Install plastic tape along both sides and the center line of the trenches at the elevation of approximately 12 inches above the top of utility.

G. Underground Water System: Prior to testing pipe provide concrete thrust blocks at changes in direction. Block size as required for types of fittings involved.

H. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.

I. No-Hub Couplings: Install per manufacturer's instructions.

J. Copper Grooved Piping System: Install in strict accordance with latest manufacturer's published literature.

3.4 PIPING JOINTS

A. Pipe and fittings shall be joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. shall be done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.

B. Copper Piping: Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished. Joint shall be uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.

C. No couplings installed in floor or wall sleeves.

D. Steel Piping:
   1. Screwed Joints: Pipes cut evenly with pipe cutter reamed to full inside diameter with all burrs and cuttings removed. Joints made up with Teflon liquid dope or Teflon tape applied to male threads only, leaving two threads bare. Joints tightened so that not more than two threads are left showing. Junctions between galvanized steel waste pipe and bell of cast iron pipe shall be made with tapped spigot or half coupling on steel pipe to form spigot end and caulked.
   2. Flanged Joints: Pressure rating of flanges shall match valve or fitting joined. Joint gaskets shall be coated with graphite and oil.

E. Welded Joints:
   1. Preparation for Welding: Bevel piping on both ends before welding:
      a. Use following weld spacing on all buttwelds:

Nominal Pipe Wall Thickness	Spacing	Bevel
1/4-inch or less	1/8-inch	37-1/2
Over 1/4-inch, less than 3/4-inch	3/16-inch	27-1/2

      b. Before welding, remove all corrosion products and foreign material from surfaces.
   2. Welded Joints: Joints shall be made by the “arc-welding” process using certified welders. Port openings of fittings must match the inside diameter of the pipe to which they are welded. Use full radius welding elbows for all turns, use welding tees for all tees. Reducing fittings must be used for size reduction. “Weldolets” may be used for branches up through one-half the pipe size of the main to which they are attached. Nipples are not allowed.
   3. Welding Operation:
      a. After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.
      b. Weld reinforcement no less than 1/16-inch not more than 1/8-inch above normal surface of jointed sections. Reinforcement crowned at center and taper on each side to surfaces being joined. Exposed surface of weld shall present professional appearance and be free of depressions below surface of jointed members.
      c. No welding shall be done when temperature of base metal is lower than 0°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Metal shall be “warm to the hand” or approximately 60°F.

F. CPVC Piping: Socket weld joints with solvent cement and application method recommended by manufacturer, use power saw and miter box to cut CPVC pipe. Allow proper curing time based on temperature range.

G. Flexible Connector: Provide where indicated on the Drawings.

3.5 ABS DWV EXPANSION JOINT

A. ABS DWV Expansion Joint:
   1. Install per manufacturer's installation instructions.
   2. Contractor is responsible to determine quantities and locations required.

3.6 ADJUSTING AND CLEANING

A. General:
   1. Clean interior of all piping before installation.
   2. Flush sediment out of all piping systems after installation before connecting plumbing fixtures to the piping.
   3. When placing the water systems in service during construction, each system shall be cleaned by circulating a solution with 1000 ppm (1#20 gallon) of trisodium phosphate for 24 hours, then drained, flushed and placed in service.
   4. Clean all strainers prior to placing in service.

3.7 INSTALLATION, NATURAL GAS PIPING

A. Install piping where shown on Drawings.

B. Black Steel Pipe:
   1. Welded joints shall be made by the "arc-welding" process by certified welders as outlined above.
   2. On piping below grade install protective pipe wrap after testing and prior to backfilling in accordance with the manufacturer's recommendations. Overlap one-half spiral lap for double thickness.
   3. Piping installed under building floor slabs in vented sleeve per code.

C. Polyethylene Pipe:
   1. Thermal Expansion:
      a. Snaking: The pipe and tubing to be "snaked" in the trench bottom with enough slack to provide for thermal expansion and contraction before stabilizing. The normal slack created by residual coiling is generally sufficient for this purpose.
      b. If, however, the pipe has been allowed to straighten before it is placed in the trench, 6 inches per 100 feet of pipe length shall be allowed for this purpose.
      c. Stabilizing:
         1) Pipe and tubing temperature to be stabilized by backfilling and leaving all joints exposed so they can be examined during the pressure test.
         2) Allow to stand overnight.
   2. Joints:
      a. Heat Fused Joints: Heat fused joints to be made as recommended by the manufacturer.
      b. Mechanical Joints: Mechanical joints to be made in an approved manner with tools recommended by the joint manufacturer. Mechanical joints shall be made with listed compression type couplings, or other listed special fittings.
      c. Joints to Other Materials: Listed plastic to steel transition fittings to be installed on each end of the plastic piping system. Transition fittings to be installed outside of building walls with metallic piping extending into the building a sufficient distance to permit the use of backup wrenches.
      d. Threaded joints or joints made with adhesives or solvent are prohibited.
   3. Pipe temperatures to be stabilized before testing.
   4. Pipe and tubing shall be installed only outside the foundation of any building or structure or parts thereof.
   5. Provide 18 gauge bare copper tracer wire over entire length of pipe.
   6. Installation shall be acceptable to the serving gas supplier.

END OF SECTION

HYDRONIC PUMPS FOR PLUMBING

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Provide centrifugal pumps.

1.3 QUALITY ASSURANCE

A. Select pump impellers such that impellers shall not be greater than minimum impeller size plus 90 percent of the difference between the maximum and minimum impeller size for pump selected.

B. Select motor to be non-overloading under all operating conditions.

C. Select pump with a minimum efficiency as listed in schedule.

1.4 SUBMITTALS

A. Submit the following:
   1. Product data for each pump including performance curves, pump efficiency, motor data, operating weights, and pressure ratings. Submit control information and wiring diagrams for packaged equipment.
   2. Operating and maintenance data for each product specified under this Section.

PART 2 - PRODUCTS

2.1 IN-LINE CIRCULATING PUMPS

A. Acceptable Manufacturers:
   1. Zoeller, Bell and Gossett, Armstrong, Paco, Peerless, Grundfos, Aurora.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Pipe mounted, integral centrifugal pump and resiliently mounted motor.
   2. Rigid coupling between pump and motor.
   3. Mechanical shaft seals.
   4. Bronze fitted construction.
   5. Rising head characteristics with decrease in volume.
   6. Drip-proof construction.
   7. Motors: 1750 RPM or 3500 RPM maximum speed as scheduled, drip proof. Refer to Section 22 05 00 for energy efficient motor requirements. Provide totally enclosed motors for pumps located in any ceiling or space used as an air plenum.

2.2 SUMP PUMP (ELEVATOR)

A. Acceptable Manufacturers:
   1. Weil, Paco, Bell & Gossett, Peabody Barnes, Aurora.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Packaged sump pump, complete including pump and controls; pump with cast iron body and motor housing, cast iron impeller, mechanical seals, stainless steel shaft and strainer.

C. Controls / Electrical: Provide float operated controls arranged to allow pump operation and alarm bell initiation. Furnish complete control unit, including disconnect, starter, TOA selector switch(es), float and high water alarm control with alarm bell, and contacts for remote alarm point pickup. Package for single point electrical connection including controls.

PART 3 - EXECUTION

3.1 IN-LINE CIRCULATING PUMP INSTALLATION

A. Motor in horizontal or vertical depending on normal design of pump.

B. Provide for convenient access to oil cups and as required by the manufacturer.

C. Provide valves and specialties as detailed on Drawings.

D. Lubricate in accordance with manufacturer's instructions before operation.

E. Support and isolate circulators as specified and as scheduled on the Drawings.

3.2 SUMP PUMP INSTALLATION

A. During construction, the contractor shall provide temporary pumps if evacuation of sump is required. Permanent pumps provided hereunder shall not be used for removal of construction debris.

B. Install pumps in sumps where shown on Drawings. Adjust sump level controls to those scheduled or detailed.

C. Provide valves and specialties as detailed on Drawings.

D. Support interconnecting piping independently to prevent stresses on casings.

3.3 FIELD QUALITY CONTROL

A. Field Test for Sump Pump and Sewage Ejector: After installation is complete, conduct a test of the system as follows:
   1. Operate complete pump sequence to assure proper operation of pumps with respect to fluid level in sumps.
   2. Confirm proper operation of lead lag sequencing.
   3. Confirm operation of both remote and local alarm devices.

B. Field Test for Water Booster: After installation is complete, conduct a test of the system as follows:
   1. Operate complete pump sequence to assure proper operation of pumps and regulating valves to maintain scheduled discharge pressure under varying inlet pressure conditions and at design conditions.
   2. Confirm proper operation of lead lag sequencing.
   3. Confirm operation of all safety devices and both remote and local alarm devices.
   4. Confirm proper air charge in hydropneumatic tank.

END OF SECTION

PLUMBING WATER TREATMENT

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Treatment of domestic water systems and solar hot water systems.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop drawings.
   2. Product data.
   3. Operating and maintenance data.
   4. Certificate of completion.
   5. Treatment Reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE CHEMICAL TREATMENT MANUFACTURER/SUPPLIER

A. US Water Services, Nalco, Mogul, Chemax, Chemcoa, DuBois Chemicals.

B. Other Manufacturer/Suppliers: Submit Substitution Request.

2.2 SOLAR HOT WATER TREATMENT (GLYCOL):

A. Closed Loop Systems Chemicals: 75 ounces of Nalco 39 per 100 gallons of water, or Mogul #7174 borate nitrite of required dosage. Filling may be through bypass shot feeder across pump.
   1. Final system treatment shall achieve 800-1200ppm Sodium Nitrite in the system water. Tolyltriazole levels of minimum 3ppm in all closed loop water shall be applied.
   2. One Shot Feeder:
      a. Description: Furnished and install one-shot chemical bypass feeders on each closed loop system where water treatment is specified.
      b. Construction: Each feeder shall be 2 quart, 4 quart, 10 quart or maximum of 5 gallon volume as required to initially treat the system served in two shots. Pressure rating shall be 150 psig or 300 psig to match other valve and pressure vessel ratings. Provide fill funnel and valve, air vent cock and drain valve and plug.
   3. Glycol Mixing Tank:
      a. Tank: 50 gallon, 90 mil polyethylene tank with 1/3 hinged PE cover. Fully support & restrain tank with painted carbon steel frame.
      b. Control Panel: NEMA 4X control panel with 115V power cord. Panel to include:
         1) 2 position main power switch and light.
         2) 3 position (hand/off/auto) switch and light for gear pump.
         3) Red low level light and dry contact for connection of alarm to the DDC system.
         4) 15 amp fuse.
         5) Audible alarm and silence switch.
      c. Low Level Switch: Polypropylene side entry low level switch with 10 amp relay.
      d. Gear Pump: 1/3 HP gear pump to provide steady and even flow of 1.5GPM at 100psi discharge pressure. Pump to have flooded suction with bronze ball valve, flexible rubbing and cast iron Y-Strainer. Pump discharge to have flexible discharge tubing, brass check valve, copper piping and 1/4-inch NPT back tap pressure gauge.

e. Pressure Switch: 1/4-inch NPT pressure switch with cut-in range of 10-45psi, cut out range of 20-50psi and psi difference of 10-30.
f. Pressure Relief Valve: 5-300psi brass pressure relief valve.
g. Manufacturer: J.L. Wingert Co. Model GL50-E1 economy glycol feed system or as approved.

2.3 PLUMBING WATER TREATMENT

A. Domestic Water Chlorination:
1. Chlorination shall be accomplished by personnel in employed of firm licensed to do this type of work.
2. As a minimum, potable water systems shall be disinfected prior to use as outlined within the current state or local Plumbing Code or as prescribed by the Health Authority, whichever requirements are more stringent.
3. Chemicals: Sodium Hypochlorite 12.5% EPA registered for drinking water application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Solar Hot Water Systems (drainback):
1. Fill system with distilled water with rust inhibitor.

B. Solar Hot Water Systems (glycol):
1. Install shot feeders across pump or appropriate restricting valve with adequate mounting to prevent piping damage and preclude transmitting vibration to structure.
2. Filling may be through bypass shot feeder across pump.
3. Final system treatment shall achieve 800-1200 ppm Sodium Nitrite in the system water. Tolyltriazole levels of minimum 3ppm in all closed loop water shall be applied.
4. Test to confirm proper inhibitor levels.
5. Install glycol mixing tank according to manufacturer’s recommendations to provide 30% concentration of glycol.
6. Install corrosion coupon rack per manufacturer’s recommendations around the supply and return side of circulating pump. Isolation valves shall be installed at each side of rack within easy reach of operator.

C. Plumbing Domestic Water Systems:
1. Provide 1/2-inch injection point on incoming water line immediately after the backflow device.
2. Flush system with fresh water to remove all dirt and construction debris.
3. Open all fixtures to develop slow rate of flow through system.
4. Injection Sodium Hypochlorite solution at a rate to achieve greater at 100 ppm chlorine at all fixtures.
5. Flush entire system so no chlorine is present.
6. Bacteriological samples shall be submitted to a certified laboratory who shall certify that the water is suitable for drinking. The certificate stating purity of water shall be delivered to the Architect.

3.2 FINAL ADJUSTMENT

A. When the systems are accepted by the Owner the chemical treatment supplier shall make final adjustments in the required concentrations.

B. Submit report of indicating initials and final concentrations and system chemistry.

END OF SECTION

PLUMBING EQUIPMENT

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 provisions of Section 22 05 00, Common Work Results for Plumbing, apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Water heaters, domestic water expansion tanks, backflow preventers.

B. Related Sections include:
   1. Section 22 40 00 Plumbing Fixtures.
   2. Section 23 51 00 Breechings, Chimneys and Stacks.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Water heaters to meet state energy code requirements.

1.4 SUBMITTALS

A. Submit the following:
   1. Product data for each item specified.
   2. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 WATER HEATERS

A. Gas Water Heater (Storage Type, Condensing, Direct Vent):
   1. Acceptable Manufacturers:
      a. Lochinvar Shield.
      b. Other Manufacturers: Submit Substitution Request.
   2. General: Provide direct vent type commercial gas-fired storage water heater of sizes, capacities and efficiencies as indicated on the Drawing Schedules.
      a. Gas water heater constructed of heavy gauge steel with ceramic glass lining applied after the tank is assembled and welded. The condensing flue coil shall be coated on the flue gas side acid resistant glass lining designed for use in condensing heaters.
      b. Insulate tank with foam insulation to comply with ASHRAE 90 standards and local codes, with a baked enamel steel jacket.
      c. ASME pressure and temperature relief valve and ASME rated pressure vessel.
      d. Safety Controls: CSD-1 and as required by current local codes for automatic operation.
      e. The following shall be factory installed and provided; high temperature limiting device, drain valve, low water protective device, dielectric nipples, flue baffle, heat traps, inlet dip tube, and suspended sacrificial anode rod.
      f. Heater and burner shall be UL listed.
      g. Water heater shall be a fully condensing unit with a 90% - 98% thermal efficiency. Refer to Drawings for efficiency at scheduled operating conditions.
      h. Unit shall be suitable for sealed combustion direct venting with 4-inch PVC combustion air vent, power venter and exhaust vent.
      i. The power burner shall be of a design that requires no special calibrations on start up. The heater shall be approved for 0-inch clearances to combustibles.
      j. The control shall be an integrated solid state temperature and ignition control device with integral diagnostics, LED fault display capability and a digital display of temperature settings.

k. The tanks shall be equipped with an ASME rated temperature pressure relief valve. The water heater shall be UL listed and exceed the minimum efficiency requirements of ASHRAE 90.
l. This heater shall be listed by SCAQMD Rule 1146.2 Low NOx.

3. Condensate Management System: Provide neutralizer kit to assure any condensate discharge is controlled to a pH range of 6.5 - 7 before discharge into the drainage system. Use materials approved by the authority having jurisdiction. Provide Owner with a one year supply of condensate neutralizer (reagent grade calcium carbonate).

2.2 BACKFLOW PREVENTERS

A. Acceptable Manufacturers:
1. Watts, Febco, Wilkins, Hersey, Ames.
2. Other Manufacturers: Submit Substitution Request.

B. Reduced Pressure Backflow Assembly (RPBA) Type:
1. 2-inch Size and Smaller: Screwed ends with bubble-tight ball valves, bronze main valve body and cover, bronze main valve with stainless steel 316 trim and four (4) test cocks. Maximum working pressure of 150 psi unless scheduled.
2. 2-1/2-inch Size and Larger: Flanged ends with non-rising stem shutoff valves, cast iron main valve body and cover with epoxy coated interior, bronze main valve trim, bronze differential relief valve with stainless steel 316 trim and four (4) test cocks. Maximum working pressure of 150 psi unless scheduled.

C. Vacuum Breakers:
1. Atmospheric Type (AVB): 1/2-inch through 2-inch size, all brass body, non-spilling type, 150 psig working pressure with maximum temperature of 140°F. Rough brass finish.

2.3 DOMESTIC WATER EXPANSION TANK

A. Acceptable Manufacturers: Amtrol, Bell & Gossett, Armstrong, Wheatley, Taco, or equal.

B. Expansion Tank: Diaphragm type of welded steel, constructed and stamped in accordance with ASME code for 150 psi working pressure. Heavy-duty butyl diaphragm shall meet FDA requirements for potable water supply. Support with steel legs or bases for vertical installation or steel saddles for horizontal installation. Tank shall be precharged with compressed air to minimum fill pressures as indicated on the Drawings.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install per manufacturer's installation instructions and in accordance with all applicable codes.

B. Provide pressure/temperature relief valve on storage tanks. Provide piping from relief valve to floor drain utilizing a 1-inch air gap at discharge point.

C. Support: Install water heater oriented so that controls and devices needing service and maintenance have adequate access. Install water heaters level. Provide required strapping to structure and floor in accordance with code requirements.

D. Gas Supply: Provide gas pipe with drip leg, tee, gas cock, union, and specialties as detailed on the Drawings. Provide gas pipe of size shown on drawings or the full size of unit inlet connection. Install piping so as not to interfere with service of units.

E. Water Piping: Provide hot and cold water piping to units with shutoff valves, unions, and specialties as detailed on the Drawings. Provide recirculating water line to unit with shutoff valve, check valve, and union.

F. Flue:
1. Connect flue to direct vent with gastight connection.
2. Refer to specification 23 51 00 for flue material.
3. Flue size and routing shall be in accordance with manufacturer's installation instructions.

G. Combustion Air Duct Vent
   1. Connect duct to water heater with gastight connection.
   2. Refer to specification 23 31 01 for duct material.
   3. Duct size and routing shall be in accordance with manufacturer's installation instructions.

H. Condensate Management System: Install in strict compliance with manufacturer's installation instructions, and local authority having jurisdiction.

3.2 BACKFLOW PREVENTERS

A. Install at height and location suitable for testing purposes by the local governing authority.

B. Provide funnel drain below reduced pressure backflow device for collecting periodic discharge and testing purposes. Pipe 2-inch indirect waste from funnel drain to floor drain. Discharge indirect waste above floor drain utilizing a 1-inch air gap.

END OF SECTION

SOLAR WATER HEATING SYSTEM

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 provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Solar heating water system equipment including solar collector panels and mounting, flow meter, heat exchanger, and storage tank.

B. Related Sections include:
1. Section 22 05 23 General Duty Valves and Specialties for Plumbing.
2. Section 22 05 29 Hangers, Supports and Anchors for Plumbing.
3. Section 22 05 53 Identification for Plumbing Piping and Equipment.
4. Section 22 07 00 Insulation for Plumbing.
5. Section 22 21 13 Pipe and Pipe Fittings Plumbing.
6. Section 22 21 23 Pumps for Plumbing.
7. Section 22 25 00 Plumbing Water Treatment.

1.3 SUBMITTALS

A. Shop Drawings:
1. Solar Collector Mounting Details: Provide layout and details of the solar collector mounting brackets and the connections to the roof system. Coordinate mounting bracket connections with roof system manufacturer. Provide certification from the roof system manufacturer that the solar collector mounting system is compatible with the roof system and will not affect the roof system warranty.

B. Product Data:
1. Solar Collectors.
2. Storage Tank.
3. Drainback Tank.
4. Heat Exchangers.
5. Flow Meter.
6. Controller.
7. Solar Collector Mounting Brackets.

C. Operation and Maintenance Data.

1.4 INCENTIVES

A. Qualifications:
1. The installing contractor shall be an approved Solar Trade Ally with the Energy Trust of Oregon.

B. Incentive Documentation:
1. The installing contractor shall assist the owner in obtaining financial incentives by performing the calculations and the paperwork required for the following programs.
   a. Energy Trust of Oregon (ETO) solar incentives program.
   b. Oregon Business Energy Tax Credit (BETC) solar thermal program.
   c. Federal Incentives will be obtained by pass thru documentation due to Non Profit Status of Building.

2. Application paperwork shall be prepared and submittal with adequate time for project incentive approval prior to purchasing any solar equipment.

PART 2 - PRODUCTS

2.1 SOLAR COLLECTOR PANEL

A. Acceptable Manufacturers:
   1. Radco, Heliodyne, SunEarth Products.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Solar collectors with extruded aluminum frame with bronze anodized finish .008" roll formed copper sheet absorber plate, absorber with black chrome selective coating over nickel plate or electrostatic acrylic black paint, 1-inch internal copper manifolds with 1/2-inch waterway tubes, EPDM inserts at manifold seals, 1/8-inch low iron tempered glass glazing, foil faced insulation board and fiberglass blanket, bronze painted and embossed 0.018-inch aluminum backing sheet. Collector shall have IAMPO listing and be SRCC certified.

2.2 STORAGE TANK

A. Acceptable Manufacturers:
   1. Niles, Lochinvar, A.O. Smith, PVI, Roy E. Hanson Jr. Mfg.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Construct tank of heavy gauge steel, fluorocarbon polymer, epoxy, or glass lined, 150 psi working pressure (ASME rated for 125 gallon size and above).
   2. Equip tank with sacrificial magnesium anode unless fluorocarbon polymer lined.
   3. Pre-Insulated tank with foam insulation, provide 2-1/2-inch (R-12) insulation with a baked enamel steel jacket.
   4. ASME rated temperature and pressure relief valve and drain valve.
   5. Tank modified with additional taps for heat exchanger piping connections.
   6. See Drawings for size, capacities and other details.

2.3 SOLAR DRAINBACK RESERVOIR

A. Acceptable Manufacturers:
   1. SunEarth, A.O. Smith.
   2. Other Manufacturers: Submit Substitution Request.

B. Compact electric water heater (power is not to be connected in this application) with top inlet connection and low, side outlet connection.

2.4 FLAT PLATE TYPE WATER-TO-WATER HEAT EXCHANGER

A. Acceptable Manufacturers:
   1. Alpha-Laval, Mueller, APV, Bell & Gosset.
   2. Other Manufacturers: Submit Substitution Request.

B. Flat plate double wall heat exchanger (suitable for use in domestic water system) shall consist of the specific number of 0.8 mm. thick pressed Type 316 stainless steel heat transfer plates as required to provide the total square footage of effective heat transfer area to meet the operating conditions specified. Each heat transfer plate shall have an integrally mounted boundary gasket of nitrile material.

C. Boundary gasketing shall be provided in such a manner that any leakage of gaskets would not intermix fluids between first and second circuit. Gasketing shall be provided in such a manner that all leaks are to an external portion of the plate heat exchange for quick detection and elimination of intermixing of primary and secondary fluids.

D. Each heat transfer plate shall be of "M" and "W" shaped herring boned corrugations to optimize heat transfer with nominal pressure losses.

E. The complete assembly shall be factory assembled and tested in accordance with the ASME Code, Section VIII, Division 1, and furnished with ASME Code certification (U-1 Form) and stamp for a design pressure of 150 psig at 150°F for both circuits.

F. All fluid contact parts on primary and secondary circuits shall be of Type 316 stainless steel material.

G. Plate corrugation to support adjacent plates at many evenly distributed support points allowing pressurization of one circuit or the other to a full 150 psig differential without deformation of buckling of heat transfer plates.

H. The plate package shall be assembled with heavy steel covers to contain the pressure utilizing alloy steel bolting of high tensile strength.

I. The flat plate heat exchanger package shall have sufficient room in the frame for addition of 25% extra heat transfer plates if required for future operation.

J. Each heat transfer plate shall be aligned within the frame by an upper stainless steel rail and a lower stainless steel guide rail. The movable cover of the plate heat exchanger shall be furnished with a steel roller for ease of movement without additional rigging or handling equipment.

2.5 FLOW METER

A. Acceptable Manufacturers: Blue-White, Letro or approved.

B. Description: Visual flow meter, chemical resistant body, 300psi operating pressure, 240°F operating temperature, #316 stainless steel float, viton o-ring seals, 10-50 GPM.

2.6 SOLAR COLLECTOR PANEL MOUNTING SYSTEM

A. Acceptable Manufacturers:
   1. SunEarth Solar Strut, Heliodyne.
   2. Other Manufacturers: Submit Substitution Request.

B. Mounting hardware:
   1. Collector mounting shall be achieved without roof penetrations.
   2. Collector mounting hardware shall be comprised of a collector manufacturer supplied aluminum clip system attached directly to the collector's mounting flange.
   3. Collector racks used to raise collectors tilt shall be fastened to structural members provided on the roof and able to sustain a wind load of not less than site loading requirements.
   4. Solar collector rack kits shall include:
      a. Extruded aluminum channeled rails.
      b. Front and back mount legs.
      c. Mounting feet or other hanger bolt connection configuration.
      d. Mounting clips, stainless steel 304 bolts, nuts and washers to assemble and attach to the collector mounting flange.

C. Mounting Approval.
   1. Structural and wind loading calculations shall be stamped and signed by a licensed engineer in the state of site construction for the collector metal framing supports and collector anchorage.

PART 3 - EXECUTION

3.1 GENERAL:

A. Install work in strict accordance with applicable codes, regulatory agencies, approved layout, and the Contract Documents, and in such a manner as to achieve required design criteria with components accurately placed and operating correctly.

B. All work shall comply with requirements for available incentive programs such as BETC and ETO.

3.2 SOLAR COLLECTOR PANEL AND MOUNTING SYSTEM

A. Install per manufacturer's instructions.

B. Connect to structural locations indicated on the drawings.

C. Each group of panels shall have its own support structure.

3.3 STORAGE TANK

A. Install per manufacturer's instructions.

B. Support on 4-inch housekeeping pad.

C. Connect piping as indicated on the Drawings.

3.4 SOLAR DRAINBACK RESERVOIR

A. Install per manufacturer's instructions.

B. Support on 4-inch housekeeping pad.

C. Connect piping as indicated on the Drawings.

3.5 FLAT PLATE TYPE WATER-TO-WATER HEAT EXCHANGER

A. Install per manufacturer's instructions.

B. Support on 4-inch housekeeping pad.

C. Connect piping as indicated on the Drawings.

3.6 FLOW METER

A. Install according to manufacturer's instructions.

B. Connect piping as indicated on the Drawings.

C. Locate to ensure that the meter is visually accessible from a permanent walking surface.

END OF SECTION

PLUMBING FIXTURES

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 provisions of Section 22 05 00, Common Work Results for Plumbing HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Plumbing fixtures.
   2. Fixture trim.
   3. Drainage products.
   4. Miscellaneous plumbing items.

1.3 QUALITY ASSURANCE

A. Water closets shall have Maximum Performance (MaP) score of no less than 800.

B. Faucets shall be certified to NSF/ANSI 61.

1.4 SUBMITTALS

A. Submit the following:
   1. Product data for each item specified.
   2. Operating and Maintenance Data:
      a. Sensor operated flush valves.
   3. Mounting heights for all fixtures.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers are stated for each fixture specified. The following manufacturers are also acceptable, except when indicated "only".

B. Drainage Products and Carrier Products: J.R. Smith, Josam, Sioux Chief, Zurn, Wade, Watts Drainage, Woodford, Mifab.

C. Fixtures: American Standard, Kohler, Sloan, Toto.

D. Seats: Olsonite, Church, Beneke, Bemis.

E. Mixing Valves: Powers, Leonard, Symmons, Chicago, Acorn SV16.

F. Stainless Steel Products: Elkay, Just, Franke.

G. Mop Sinks: Fiat, Williams, Mustee.

H. Wash Stations: Bradley, SloanStone.

I. Drinking Fountains: Elkay, Acorn.

J. Showers: Moen, Delta.

K. Faucets: Chicago, Elkay, Delta Commercial, Kohler, Moen Commercial, Sloan.

L. Shock Arrestors: PPP, J.R. Smith.

M. Trap Primer Stations: PPP, J.R. Smith.

N. Exposed Waste and Supply Piping Insulation Kits: Truebro, McGuire.

O. Other Manufacturers: Submit Substitution Request.

2.2 FIXTURE TRIM

A. Supply Stops: Chicago cast brass rigid riser supplies with loose key angle stops, wall flanges, NPT female inlet, all chrome plate finish; equivalent NPT McGuire (LK series), Brasscraft (SCR series) or NPT stops by fixture supplier.

B. Traps:
1. For floor drains, provide coated cast iron P-trap; recessed, screw jointed or bell and spigot.
2. For other fixtures, provide 17 gauge, chrome plated cast brass P-Traps with solder bushings, and clean-out.

C. Support Rims: Hudee stainless steel rims, if sink not furnished with integral rim.

D. Vacuum Breakers: Chicago Faucet, A.W. Cash or Febco chrome plated.

2.3 PLUMBING FIXTURES

A. WC-1 Water Closet:
1. Kohler “Kingston”, vitreous china, wall hung, elongated bowl, siphon jet action, 1-1/2-inch top spud, white color finish. Complete with Sloan Regal 111-1.28 battery powered sensor flushometer, with vandal-proof cap.
2. Bemis 1600 series white open-front seat, less cover with external check hinge including 300 series stainless steel post and pintles to stop seat at 11 degrees beyond vertical.
3. J.R. Smith Series 200 chair carrier.

B. WC-2 Water Closet(Adult ADA):
1. Kohler “Kingston”, vitreous china, wall hung, elongated bowl, siphon jet action, 1-1/2-inch top spud, white color finish. Complete with Sloan Regal 111-1.28 battery powered sensor flushometer with vandal-proof cap.
2. Bemis 1600 series white open-front seat, less cover with external check hinge including 300 series stainless steel post and pintles to stop seat at 11 degrees beyond vertical.
3. J.R. Smith Series 200 chair carrier.

C. U-1 Urinal:
1. Kohler Bardon, vitreous china, wall mounted wash down urinal with 3/4-inch top spud, white color finish. Complete with Sloan Optima 186-0.5 XL SMO sensor activated valve with dual filtered fixed bypass diaphragm, battery powered, with vandal proof cap (0.5 GPF).
2. J. R. Smith Series 600 floor mounted urinal support.

D. L-1 Lavatory :
1. Kohler Kingston K-2005 21-1/4 x 18-1/8-inch, vitreous china, self-draining deck, backsplash, 4-inch centers, wall hung, concealed arm support, grid drain, white color finish.
2. Chicago 802 series faucet with polished chrome plated solid brass body construction, 4-inch spout, vandal proof metering push handle, 1/2 GPM pressure compensating aerator, adjustable cycle time closure cartridge, vandal resistant complete.

E. WS-1 Wash Station (ADA):
1. Bradley, model LVRD2 series, wall hung, equipped with Chicago MVP 3500 faucet, 0.5 gpm, manual push button metering faucet with single supply for tempered water service, and Chicago ECAST thermostatic mixing valve.

F. WS-2 Wash Station (ADA):
1. Bradley, model EXD-3N series wall-hung equipped with Bradley Aerada 900 Series Futura Electronic faucet, 0.5 gpm, battery operated infrared sensor.

G. S-1 Sink:
   1. Elkay model ELUHAD series A.D.A. compliant gourmet undermount sink. ADA compliant, single compartment, 18 gauge, Type 304, 1-hole center, self-rimming, stainless steel sink; LK-18 grid strainer.
   2. Chicago 748 series deck mounted, single hole drinking fountain chrome plated solid brass body construction, vandal proof metering push handle, anti-microbial flexible mouth guard.
   3. Chicago 2300-8 series ceramic deck mounted, single hole mixing sink faucet, 10” cast brass spout, single handle, 2.2 GPM pressure compensating laminar flow outlet, vandal resistant complete.

H. S-2 Sink:
   1. Elkay model ELUHAD series A.D.A. compliant gourmet undermount sink. ADA compliant, single compartment, 18 gauge, Type 304, 1-hole center, self-rimming, stainless steel sink; LK-18 grid strainer.
   2. Chicago 2300-8 series ceramic deck mounted, single hole mixing sink faucet, 10” cast brass spout, single handle, 2.2 GPM pressure compensating laminar flow outlet, vandal resistant complete.

I. S-3 Sink:
   1. Elkay model SE Super Economy Series Sink (SE2C18x18-2-18X) free standing sink. Two compartments, two drain boards, backsplash, 18 gauge, Type 300, 1-hole center (each compartment), self-rimming, stainless steel sink; LK-99 grid strainer .
   2. Chicago 640-L8E1-317YAB series, ceramic wall mount 8-inch center commercial faucet, two hole dual handle wall mount faucet with 4-inch wrist blades, 1/2” rigid solid brass spout, single handle, 2.2 GPM pressure compensating laminar flow outlet, vandal resistant complete.

J. S-4 Sink:
   1. Elkay model DLR (312212) series top mount sink. Single compartment, 18 gauge, Type 304, 1-hole center, self-rimming, stainless steel sink; LK-99 grid strainer.
   2. Chicago 350-VPAXKABCP series, ceramic single hole supply sink faucet, 13” high rigid solid brass swing gooseneck spout, single handle, 2.2 GPM pressure compensating laminar flow outlet, vandal resistant complete.

K. S-5 Sink:
   1. Elkay model ELUHAD series A.D.A. compliant gourmet undermount sink. ADA compliant, single compartment, 18 gauge, Type 304, 1-hole center, self-rimming, stainless steel sink; LK-18 grid strainer.
   2. Chicago 2300-8 series ceramic deck mounted, single hole mixing sink faucet, 10” cast brass spout, single handle, 2.2 GPM pressure compensating laminar flow outlet, vandal resistant complete.
   3. Speakman SE-572 series integral countertop mounted emergency eyewash, aerated with flip-top dust caps, stainless steel push handle activation, ½” inlet, 3 GPM @ 30 psi.

L. MS-1 Mop Sink:
   1. Fiat TSB series, 28x28x12-inch molded stone mop basin, wall bracket, 5-foot hose, bumper guards & wall guards (two sides).
   2. Chicago 540 series ceramic wall mounted service faucet with polished chrome plated solid brass body construction, lever handles, pail hook, wall brace, vacuum breaker, check stops and hose thread outlet.

M. SH-1 Shower (ADA):
   1. Moen Commercial Shower, Model 8342EP15 assembly with polished chrome finish, pressure balance mixing valve (Acorn SV16), high temperature limit stop, lever handle, 1.5 GPM hand held shower with 2 integral check valves and 69-inch hose and slide bar, 24-inch ADA wall/grab bar and rough in kit.
   2. J.R. Smith 200 series floor drain with nickel bronze grate.

N. Master Mixing Valve Assembly: Leonard Type TM New Generation High Low, exposed, factory tested and assembled mixing valve assembly consisting of but not limited to: large and small rough bronze finish thermostatic mixing valves, high temperature limit stops, angle checkstops, outlet ball valve shutoffs, built-in spring check valve with pressure gauges, thermometer, inlet piping manifolds with unions. Unit to control discharge temperature to ±1%. Unit shall be mounted in locking stainless steel cabinet. See schedule on drawings for capacities.

O. DF-1 Drinking Fountain (ADA): Elkay LZWS-EDFPBM117K series dual height wall hung drinking fountain with integral bottle filler.
   1. Surface mounted fountain.
   2. Contoured basins.
   3. Push pad operated bubblers.
   4. Vandal resistant bubbler guards.
   5. Surface mounting plate.
   6. 1.5 GPM Bottle Filler.

P. Exposed Waste and Supply Piping Insulation Kits: McGuire Prowrap insulation kit for exposed supplies and waste piping below ADA lavatories and ADA sinks.

2.4 DRAINAGE PRODUCTS

A. HB-1 Hose Bibb: Chicago 952 series, chrome-plated, removable key, 3/4-inch hose thread, integral vacuum breaker.

B. WH-1 Wall Hydrant: J.R. Smith Fig. 5609QT, bronze finish, loose key, 3/4-inch hose thread, integral vacuum breaker, freeze proof.

C. WSCB-1 Water Supply Control Box (for Garbage Can Wash): J.R. Smith 3380 series, recessed water supply control box in type 304 stainless steel with a No. 4 satin finish, cylinder type key lock, cold and hot water screwdriver stops, flow control valve, and atmospheric vacuum breaker.

D. RD-1 Roof Drain (Small Area): J.R. Smith1330 series, 8-1/2-inch low profile diameter dome, cast iron body with combined flashing clamp and gravel stop, no-hub outlet and under deck clamp.

E. OD-1 Overflow Roof Drain (Small Area Overflow): J.R. Smith 1330 series, 8-1/2-inch low profile diameter dome, 2-inch high solid water dam, cast iron body with combined flashing clamp and gravel stop, no-hub outlet and under deck clamp.

F. FD-1 Floor Drain: J.R. Smith 2005 series, round nickel bronze vandal resistant grate, cast iron body with flashing collar and adjustable strainer head and no-hub outlet.

G. FD-2 Floor Drain (Unfinished Areas): J.R. Smith 2110 series, round cast iron grate, cast iron body, no-hub outlet, sediment bucket.

H. FD-3 Floor Drain (Finished Areas - Kitchens): J.R. Smith 2010 series, vandal-proof, square nickel bronze hinged grate, sediment bucket, cast iron body with flashing collar, adjustable strainer head and no-hub outlet

I. FD-4 Floor Drain (Garbage Can Wash Drain): J.R. Smith 3370 series, acid resisting coated interior, nickel bronze grate, free standing sediment bucket lined with 1/4-inch stainless steel mesh screen, no-hub outlet and bronze adjustable nozzle assembly. FS-1 Floor Sink (Finished Areas - Kitchens): J.R. Smith 3101-12 series, acid resistant coated floor sink, vandal-proof 8-1/2 x 8-1/2-inch nickel bronze 1/2 grate and sediment bucket, no-hub outlet and flashing collar.

J. FS-1 Floor Sink (Finished Areas - Kitchens): J.R. Smith 3101-12 series, acid resistant coated floor sink, vandal-proof 8-1/2 x 8-1/2-inch nickel bronze 1/2 grate and sediment bucket, no-hub outlet and flashing collar.

K. FS-2 Floor Sink (Finished Areas - Kitchens): Same as FS-1, except with 3/4 grate.

L. FS-3 Floor Sink (Finished Areas - Kitchens): Same as FS-1, except no grate.

M. FS-4Floor Sink (mechanical room indirect waste): J.R. Smith3041series floor sink with 8-inch deep receptor, basket strainer, 1/2 cast iron grate, no-hub outlet and flashing collar..

N. WCO Wall Cleanout: J.R. Smith 4530 series, round stainless steel vandal resistant cover and screw.

O. FCO Floor Cleanout: J.R. Smith 4020 series, round vandal resistant, nickel bronze top.

P. CTG Cleanout to Grade: J.R. Smith 4220 series, round, extra heavy duty cast iron top set in 12x12x4-inch deep concrete pad, vandal resistant.

Q. DSB-1 Downspout Boot: J.R. Smith 1787 series, 4-inch round downspout connection.

R. DSB-2 Downspout Boot: J.R. Smith 1785 series, 4x3-inch rectangular downspout connection.

S. Trap Priming Valves: Precision Plumbing Products Prime-time electronic trap priming manifold including but not limited to: atmospheric vacuum breaker, pre-set 24 hour clock, manual over ride, 120V solenoid valve, calibrated manifold for equal water distribution, 3/4-inch water hammer arrestor. Components pre-installed in recessed steel cabinet with SS access door.

T. Water Hammer Arrester: J.R. Smith 5005 – 5050 series, Precision Plumbing Products Model SC (Maintenance-Free).

PART 3 - EXECUTION

3.1 FIXTURE TRIM

A. Provide plumbing fixture trim where applicable on fixtures, including but not limited to supply stops, traps, support rims, flush valve, and vacuum breakers.

B. Provide rough-in and final piping connection to fixtures. Carefully review all construction documents to assure that all fixtures are provided with necessary services for a complete operating system.

C. Rigidly secure rough-in piping, carriers and supports, and other service piping to structure.

3.2 PLUMBING FIXTURES

A. Americans with Disabilities Act:
   1. Those fixtures indicated by “ADA” shall comply with and be installed in accordance with Americans with Disabilities Act Guidelines (ADAAG). Where applicable building code requirements are more stringent than ADAAG guidelines, building code requirements shall be followed.
   2. Water Closets:
      a. Mounting height of ADA water closet shall be 17 to 19 inches from floor to top of the toilet seat.
      b. Mount flush valve for ADA water closets on wide side of enclosure.
   3. Lavatories:
      a. Mounting height of ADA lavatories shall be at a maximum height of 34 inches from floor to rim.
      b. Provide insulation kits on exposed hot water and waste piping beneath ADA lavatories.
   4. Sinks: Provide insulation kits on exposed hot water and waste piping beneath ADA sinks.
   5. Urinals:
      a. Mounting height of ADA water closet shall be at a maximum height of 17 inches from floor to rim.

B. Fixture Mounting Heights: All fixtures standard rough-in catalogued heights unless shown otherwise on the Architectural Drawings.

C. Showers:
   1. Piping from shower mixing valve to shower head shall be rigid pipe. PEX piping not allowed.
   2. Shower Head Mounting Heights: Mount so that face of head is at 6'-6" above finished floor and shall not conflict with shower enclosure.

D. Water Supplies: When both hot and cold water to a fixture is required, connect the hot on the left and the cold on the right.

E. Lavatories:
   1. Public toilet room lavatories shall have grid strainers.
   2. Those lavatories indicated as "ADA" are ADA compatible. Coordinate with Architect to verify if all wall hung lavatories are to be installed at ADA height.

F. Floor Drain and Floor Sinks:
   1. Set top flush with finished floor.
   2. Provide flashing clamp for all drain bodies installed in floors provided with waterproof membranes.

G. Cleanout:
   1. Where shown or required.
   2. Cover set flush with finished surface.

H. Roof and Area Drains: Provide sump receivers for all drains except poured in place installations. Provide extension section as required to compensate for the specified insulation thickness above the roof slab or deck.

I. Water Hammer Arresters: Provide where shown and where recommended by Plumbing Drainage Institute (PDI).

J. Drinking Fountains:
   1. All water-bearing materials shall comply with the Safe Drinking Water Act of 1986 and the Lead Contamination Control Act of 1988. The waterway system of the unit shall be manufactured of copper components and other completely lead-free materials.
   2. Provide fixture manufacturer's wall mounting plate or floor mounted support for all wall-hung drinking fountains.

K. Mixing Valves: Provide piping connections per manufacturer's installation instructions.

L. Wall hung lavatories with pop-up waste assemblies: Contractor shall verify there is no vertical pull rod assembly conflict with lavatory backsplash prior to submitting product data.

3.3 PRIMING VALVES

A. All floor drains, floor sinks and similar traps shall be primed. Use minimum 3/8-inch type K annealed copper tubing. Primer line to be continuous and without joints.

B. Where priming valves are installed in finished rooms, conceal in wall and provide access panel.

C. Coordinate locations of electronic trap primer stations with electrical contractor for 120V service.

3.4 KITCHEN EQUIPMENT

A. General: Kitchen equipment is supplied and set in place by Kitchen Supplier, installed in construction contract. Obtain drawings before any rough-in is started. Complete installation and furnish all equipment required or scheduled below to give complete working installation. Symbol numbers are indicated by oval symbol with number inside. See "PLUMBING FIXTURES" for supply types and traps.

END OF SECTION

COMMON WORK RESULTS FOR HVAC

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 provisions of This Section, Common Work Results for HVAC, apply to all sections in Division 23.

C. All Sections of Division 23 are interrelated. When interpreting any direction, material, and method specified in any section of Division 23, consider it within the entirety of Work in Division 23.

1.2 SUMMARY

A. The intent of Division 23 Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 23 and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

B. The Division 23 Specifications and the accompanying Drawings are complementary and what is called for by one shall be as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications shall supersede drawings in case of conflict.

C. Imperative language is frequently used in Division 23 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.

D. The Drawings that accompany the Division 23 Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions shall be assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.

1.3 RELATED WORK

A. The General and Supplemental Conditions apply to this Division, including but not limited to:
   1. Drawings and specifications.
   2. Public ordinances, permits.
   3. Include payments and fees required by governing authorities for work of this Division.

B. Division 1, General Requirements, applies to this Division.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All products and equipment shall comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipments from approved manufacturers with equal performance characteristics.
   2. General: All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations.
   3. Contractor responsible for obtaining and payment for all permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire mechanical system and apparatus shall operate at full capacity without objectionable noise or vibration.

E. All equipment shall be installed level and true. Housekeeping pads and curbs shall account for floor or roof slope.

F. Materials and Equipment:
   1. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name along with other manufacturers.
   2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
   3. Furnish all materials and equipment of size, make, type, and quality herein specified.
   4. Equipment scheduled by performance or model number shall be considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for all changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:
   1. General: All materials shall be installed in a neat and professional manner.
   2. Manufacturer’s Instructions: Follow manufacturer’s directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 23 Specifications, obtain clarification before starting work.

H. Cutting and Patching:
   1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
   2. Additional openings required in building construction shall be made by drilling or cutting. Use of jackhammer is specifically prohibited.
   3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
   4. Beams or columns shall not be pierced without permission of Architect and then only as directed.
   5. All new work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.5 SUBMITTALS

A. Submittal in accordance with section 01 33 00- Submittal Procedures.

B. Shop Drawings:
   1. The Contract Drawings indicate the general layout of the piping, ductwork, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of all piping, ductwork and equipment installations. Shop Drawings shall be new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. All drawings shall be same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. All drawings shall be fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
   2. Shop drawings shall be prepared in two-dimensional format.
   3. Shop drawings shall include but are not limited to:
      a. Complete floor plans with sheet metal and HVAC piping to a minimum of 1/4-inch equals 1'-0" scale.
      b. Sheet metal and HVAC piping of mechanical and fan rooms to a minimum of 1/2-inch equal 1'-0" scale.
      c. Sections of congested areas to a minimum of 1/2-inch = 1'-0" scale.
      d. Controls and Instrumentation: Scale and drawing sizes to suit controls supplier.
      e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment shall not be less than 1/4-inch equals 1'-0" scale.
      f. Superplot plans of above ground work with a colored overlay of all trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2" = 1”-0” scale.
      g. Superplot plans of below ground work with a colored overlay of all trades including, but not limited to, structural footings and foundation, HVAC piping, civil piping, plumbing piping, and power conduit to a minimum of 1/2" = 1”-0” scale.
      h. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4" = 1'-0" scale.
      i. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1”-0” scale.
      j. Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.
   4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

C. Product Data:
   1. In general, submit product data for review on all scheduled pieces of equipment, on all equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets shall include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
   2. List the name of the motor manufacturer and service factor for each piece of equipment.
   3. Indicate equipment operating weights including bases and weight distribution at support points.
   4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

D. Submission Requirements:
   1. Shop Drawings and Product Data:
      a. Refer to Division 1 for additional requirements related to submittals.
      b. Submit electronic copies of shop drawings and product data for Work of Division 23 in PDF format with each item filed under a folder and labeled with its respective specification section number, article and paragraph and mark if applicable.
      c. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.

E. Contractor Responsibilities: It shall be the Contractor's responsibility to:
   1. See that all submittals are submitted at one time and are in proper order.
   2. Ensure that all equipment will fit in the space provided.
   3. Assure that all deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.6 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

A. Refer to Division 1 Section 01 7823 Operation and Maintenance Data for additional requirements.

B. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions shall cover all phases of control.

C. Furnish competent engineer knowledgeable in this building system for minimum of five 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Contractor shall keep a log of this instruction including dates, times, subjects, and those present and shall present such log when requested by Architect.

1.7 PROJECT CONDITIONS

A. Existing Conditions: Prior to bidding, verify and become familiar with all existing conditions by visiting the site, and include all factors which may affect the execution of this Work. Include all related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City and Utility Company.

1.8 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.9 PROVISIONS FOR LARGE EQUIPMENT

A. Contractor shall make provisions for the necessary openings in building to allow for admittance of all equipment.

1.10 TEST REPORTS AND CERTIFICATES

A. Contractor shall submit one copy of all test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

A. Contractor shall submit any requests for product substitutions in accordance with the Instructions to Bidders, Section 01 60 00 – Product Requirements and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Furnish under this Division as specified in Section 08 31 00 – Access Doors & Panels.

2.2 PIPE AND DUCT SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron.

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.3 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:
   1. Floor Plates: Cast brass, chromium plated.
   2. Wall and Ceiling Plates: Spun aluminum.

2.4 MACHINERY GUARDS

A. Furnish guards for protection on all rotating and moving parts of equipment. Provide guards for all metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.

B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.

C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards shall be easily removable for pulley adjustment or removal and changing of belts.

D. All guards shall meet OSHA requirements including back plates.

E. Provide inlet and outlet screens on all fans in plenums or where exposed to personnel.

2.5 ELECTRICAL EQUIPMENT

A. General: All equipment and installed work shall be as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available fault current rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment with a Short Circuit Current Rating (SCCR) that meets the bracing requirement.

C. Motors:
   1. Motors shall be furnished as integral part of driven equipment. They shall be drip proof induction type with ball bearings unless noted otherwise. Motors 1 HP and above shall be premium energy efficient type, except for emergency equipment motors. Motors shall be built to NEMA Standards for the service intended. The motors shall be rated for the voltage specified, suitable for operation within the range of 10% above to 10% below the specified voltage.

2. Energy efficient motors shall be Baldor, Westinghouse, and General Electric or approved equal.
3. The motor shall meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	**KW**	**900**	**1200**	**1800**	**3600**
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5
7.5	5.6	87.5	91.7	91.7	91.0
10	7.5	88.5	91.7	91.7	91.7
15	7.5	88.5	91.7	92.4	91.7
20	15.9	90.2	92.4	93.0	92.4

4. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage and phase.
5. Refer to individual product sections for additional motor requirements.
6. Furnish motors on belt drive equipment of nominal nameplate horsepower not less than 120% of equipment brake horsepower required for performance specified.
7. Motors shall have built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors shall have quick trip devices.
8. All motors controlled by variable frequency drives shall be inverter duty rated and have Class F insulation or better. They shall also be able to withstand repeated voltage peaks of 1600 volts with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
9. Motors served from variable frequency drives shall be equipped with shaft grounding system which shall provide a path for current to flow between the shaft and motor frame. SGS or equal.
10. Motors located in environment air plenums not tied to air handling functions shall be totally enclosed type motors.

D. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

E. Equipment Wiring: Interconnecting wiring within or on a piece of mechanical equipment shall be provided with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

F. Control Wiring: All control wiring for mechanical equipment shall be provided under Section 23 09 00, Instrumentation and Controls for HVAC.

G. Codes: All electrical equipment and products shall bear the Underwriters label as required by governing codes and ordinances.

PART 3 - EXECUTION

3.1 ACCESS PANELS

A. Install in accord with manufacturer's recommendations, coordinated with architectural features.

B. Provide 2-hour fire rated doors where required bearing the U.L. label.

C. Furnish 18x18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12"x12" for walls unless indicated otherwise.

D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.2 SLEEVES

A. Interior Floor and Wall Sleeves: Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork. Where pipe or ductwork is insulated, insulation shall pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve. Penetrations through mechanical room and fan room floors shall be made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Sleeves Through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping or duct material, size and service.

C. Sleeves specified or indicated at fire damper penetrations shall take precedence over this article.

D. Exterior Wall Sleeves Below Grade: Provide water tight sleeves. Install at pipes entering building below grade and where shown. Adjust to provide positive hydrostatic seal. Contractor shall be responsible for following manufacturer's procedure for installing and tightening seal. Secure sleeves against displacement.

E. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

F. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

G. Layout work prior to concrete forming. Do all cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

H. All floor sleeves shall maintain a water barrier by providing a water tight seal or they shall extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2 inches above finished floor level. Sleeves through roof shall extend 8 inches above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated.

I. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.

J. Special sleeves detailed on drawings shall take precedence over this section.

3.3 CLEANING

A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.4 EQUIPMENT PROTECTION

A. Keep pipe, ductwork and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.5 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms and walkways.

3.6 FLOOR, WALL AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates shall completely cover opening around pipe and duct.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates shall not penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.7 PAINTING

A. General: Coordinate painting of mechanical equipment and items with products and methods in conformance with Section 099000- Painting & Coating. All exposed work under this division shall receive either a factory painted finish or a field prime coat finish, except:
   1. Exposed copper piping.
   2. Aluminum jacketed outdoor insulated piping.

B. Equipment Rooms and Finished Areas:
   1. Insulation: Not painted.
   2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
   3. Steel Valve Bodies and Bonnets: One coat of black enamel.
   4. Brass Valve Bodies: Not painted.
   5. Equipment: One coat of grey machinery enamel. Do not paint nameplates.
   6. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers and registers flat black.

C. Concealed Spaces (above ceilings, not visible):
   1. Insulation: Not painted.
   2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.

D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.

E. Roof Mounted Equipment: Paint two coats of exterior machinery enamel. Color as selected by Architect. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.

F. Exterior Black Steel Pipe: Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel. Painting schemes shall comply with ANSI A13.1.

3.8 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.9 ELECTRICAL EQUIPMENT

A. Ductwork or piping for mechanical systems not serving electrical space shall not be installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Ductwork or piping for mechanical systems shall not pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

A. Make final connections to equipment specified in sections other than Division 23 of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.

B. Piping:
   1. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
   2. All piping connections shall be independently supported to prevent undue strain on equipment.

C. Ductwork: Make exhaust connections to fume hoods and any other processing, laboratory, or kitchen equipment in strict accordance with manufacturer's instructions.

D. Refer to Specification Section 11 40 00 Food Service Equipment for requirements.

END OF SECTION

VARIABLE FREQUENCY DRIVES FOR HVAC EQUIPMENT

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Variable frequency drives.

1.3 SUBMITTALS

A. Submit the following:
   1. Product data on variable frequency drives and related components.
   2. Start up log/check list showing successful operation.
   3. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Acceptable Manufacturers:
   1. Reliance, Toshiba, ABB, Cirrus, Emerson, Yaskawa, Square D, Siemens, Saftronics, Allen-Bradley, Danfoss.
   2. Other Manufacturers: Submit substitution request.

B. General Description:
   1. Variable frequency AC motor drive (VFD) to be of pulse width modulated (PWM) inverter type. The VFD designed to convert 60 Hz input power to adjustable frequency output power to provide positive speed control to standard induction motors. The VFD to be dedicated variable torque design for specific use with centrifugal loads.
   2. Provide completely solid state variable frequency power and logic unit.
   3. Speed control to be stepless throughout the range under variable torque load on continuous basis. Speed controlled by remote building energy management system providing 4-20MA input signal to drive and remote start/stop signal. Coordinate with Section 23 09 00.
   4. Provide adjustable frequency control with diode bridge/capacity input designed to provide high, constant power factor of 0.95 regardless of load or speed and eliminate SCR line noise.
   5. Equipment will be designed and manufactured in accordance with applicable current NEMA and IEEE recommendations and be designed for installation per NEC. Equipment will be UL listed and bear the UL label.
   6. Control shall be suitable for operation in ambient temperatures of 0 to 40°C.
   7. Every VFD shall be factory tested with an AC induction motor 100% loaded and temperature cycled within an environmental chamber at 104°F.

C. Self Protection and Reliability Features:
   1. Adjustable current limit to 60 to 110% of drive rating.
   2. Adjustable instantaneous overcurrent trip.
   3. Under voltage trip.
   4. Over temperature trip.
   5. Short circuit protection phase to phase and phase to ground faults phase rotation insensitive.
   6. Momentary power loss, more than 17 milliseconds.
   7. Transient protection against all normal transients and surges in incoming power line.

8. Orderly shutdown in event of any of above conditions, drive shall be designed to shut down safely without component failure.
9. Provide visual indication and manual reset.

D. Standard Features:
1. Drive logic shall be microprocessor based. Control logic shall be isolated from power circuitry.
2. Stand alone operation to facilitate start up and troubleshooting procedures.
3. VFD shall be UL 508C listed for drives serving a single motor or UL 508A listed for drives serving multiple motors, for use on distribution systems with 22,000 AIC.
4. Output voltages shall be equal to applied input voltage.
5. Isolated signal inputs.
6. Frequency Stability. Output frequency will be held to +0.1% of maximum frequency regardless of load, +10% input voltage change or temperature changes within ambient specification.
7. Built-in digital display shall indicate output frequency, voltage and current and shall provide indication of over current, over voltage, current limit, ground fault, over temperature, input power on, minimum or maximum speed adjustment, power on, fault condition. Display shall be on panel face.
8. Start/Stop Control - Controlled decelerated stop.
9. Primary and secondary fused for a control circuit transformer.
10. Minimum and maximum speed control.
11. Adjustable Accel/Decel - independently adjustable 10-100 second.
12. Hand-Off auto switches.
13. Programmable Auto Restart - after power outage.
14. Provide fused disconnect, including auxiliary contacts to isolate control circuit when disconnect is in “off” position, except fused disconnects not required where packaged equipment is provided with a single point connection with single point disconnect and internal overcurrent protection for VFD and motors.
15. Remote contacts for fault, and on/off status.
16. Adjustable motor output voltage.
17. Analog output voltage of 0-10 VDC, -20 MA proportional to control output frequency.
18. Provide a NEMA 1 enclosure for indoor applications and NEMA 3R enclosure for outdoor applications to isolate each motor starter and control section with its associated disconnect switch.
19. Manual speed control for each motor.
20. Manual bypass (3 contactor) to provide ability to service control while motor is operational.
21. Provide RF, and EMI, noise suppression network to limit RF and EM interference.
22. Provide isolated analog output signals for volts, amps, and frequency, from each VFD for connection to the building energy management system.
23. Provide line (input) reactors.
24. Provide output filters for all VFD’s located more than 25 conductor feet from the motor they serve. Output reactors shall permit VFD’s to be located up to 350’ from the motors they serve.
25. VFD shall be designed to catch a spinning load in forward and reverse direction.
26. Harmonic calculations shall be performed on a manufacturer supplied Harmonic Analysis program to provide conformance with IEEE 519-1992.
27. Automatic Bypass option.

E. Communications:
1. Provide factory installed communication chip for direct network connection to DDC Control System specified in Section 23 09 93. Interface shall allow for all control and interface functions specified herein and in Section 23 09 93. Interface control functions and information shall include, but not be limited to the following:
    a. Start/Stop
    b. Change Directions
    c. Drive Fault
    d. Drive Fault Codes

e. Reset Drive
f. Percent Output
g. Speed
h. Power
i. Drive Temp
j. KWH
k. Run Time

2. Provide isolated analog output signals for volts, amps and frequency from each VFD for connection to the DDC Control System specified in Section 23 09 93.
3. Provide RS485 communications port and programming software capability.

PART 3 - EXECUTION

3.1 VARIABLE FREQUENCY DRIVE INSTALLATION

A. Install VFD in accordance with manufacturer's written installation instructions.

B. Install on strut support stand.

C. Provide one drive for each motor as scheduled.

3.2 START UP

A. General: Comply with manufacturer's instructions for startup.

B. Startup shall be provided under the direct supervision of the manufacturer's representative with factory trained personnel.

3.3 FIELD QUALITY CONTROL

A. Prior to installation, manufacturer's representative shall coordinate variable speed drive control interface with the controls contractor and verify that intended installation (controls, wiring, etc.) complies with the manufacturer's recommendations.

B. Field Test: Except where initial variable speed drive operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests performed by the manufacturer's representative in the presence of the Engineer.

END OF SECTION

HVAC EXPANSION COMPENSATION

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Expansion joints and compensation.

B. Related Sections include:
1. Section 23 05 29 Hangers, Supports and Anchors for HVAC.
2. Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment
3. Section 23 21 13 Pipe and Pipe Fittings HVAC.

1.3 QUALITY ASSURANCE

A. The expansion joints, pipe guides, and related supports, braces, and anchorages to building structure shall be designed to absorb thermal expansion and contraction of piping and terminal movement, as well as resist the static and dynamic loads due to fluid flow at design conditions, hydraulic testing pressures, and seismic forces.

B. The system of expansion joints, guides, and related supports, braces, and anchorage to building structure shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.

C. Use expansion joints in straight lengths of rigid pipe; preferably welded steel, anchored and guided in accordance with best practices recommendations of Crocker and King, Piping Handbook, latest edition.

D. Avoid use of expansion joints in conjunction with U-bends or other piping systems with “inherent” flexibility.. If expansion joints are used in piping with bends, thorough analysis of pipe stresses and deflections shall be conducted and extra care and attention shall be paid to radial thrust capacity of pipe guides, braces, and anchors.

E. Design shall include:
1. Pipe stress analysis indicating loads, deflections, and pipe stress at critical points throughout the piping systems under the following conditions:
    a. At hydraulic design test pressure and ambient water temperature.
    b. At design operating temperature, pressure, and flow.
    c. Model number, size, location, and details of expansion joints, compensator guides, supports, braces, and anchorage to building structure, with substantiating calculations that the components and building can accept the calculated loads and deflections.
    d. Detailed shop drawings stamped and signed by a registered professional engineer.
    e. Structural details and calculations stamped and signed by a registered professional structural engineer.
    f. Expansion Joints to be designed and manufactured to the current Expansion Joint Manufacturers Association (EJMA) standards. Manufacturer of expansion joints to be certified by EJMA.

1.4 SUBMITTALS

A. Submit the following:
   1. Product data.
   2. Shop Drawings showing details of construction, dimensions, arrangement of components, and isolation.
   3. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
   4. Specified testing requirements.
   5. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS AND COMPENSATORS

A. Acceptable Manufacturers:
   1. Flexonics, Keflex, Hyspan, Metraflex..
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Expansion compensators to be of the packless, externally pressurized type to allow for axial movement constructed of stainless steel bellows, stainless steel shroud, integral guide rings, internal liner, limit stops, with drain port and plug.
   2. All materials of construction and pressure ratings shall be appropriate for the application as specified for each piping material and service.

2.2 EXPANSION LOOPS / SEISMIC EXPANSION JOINTS

A. Acceptable Manufacturers:
   1. Metraflex Metraloop.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Flexible stainless steel hose and braid connector. .
   2. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.
   3. All materials of construction and pressure ratings shall be appropriate for the application as specified for each piping material and service.

2.3 PIPE GUIDES

A. Acceptable Manufacturers: Hyspan, Grinnell, Flexonics, Adsco, Pipe Shields Inc., Unistrut, or equal.

B. Spider Clamp Assembly: Heavy gauge pressed steel, fusion welded, bolted construction, black enamel finish. Hyspan series 9500, or equal.

PART 3 - EXECUTION

3.1 EXPANSION JOINTS AND COMPENSATORS

A. Install in all piping risers in wood structures to compensate for ½" of shrinkage per floor. Contractor is responsible to determine quantities and locations required.

B. Install in piping to compensate for thermal expansion and contraction. Contractor is responsible to determine quantities and locations required.

C. Install in other locations indicated on the drawings.

D. Provide and install pipe alignment guides as recommended by the expansion joint manufacturer with the first guide no more than 4 pipe diameters away from the expansion joint or compensator and second guide no more than 14 pipe diameters from first guide.

E. Install per manufacturer’s installation instructions.

3.2 EXPANSION LOOP / SEISMIC EXPANSION JOINT

A. Install at building seismic expansion joints.

B. Install in piping to compensate for thermal expansion and contraction. Contractor is responsible to determine quantities and locations required.

C. Install in other locations indicated on the drawings.

D. Install per manufacturer’s installation instructions.

END OF SECTION

METERS AND GAUGES FOR HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
1. Thermometers
2. Pressure Gauges
3. Differential Pressure Gauges
4. Water Meters

1.3 SUBMITTALS

A. Submit the following:
1. Products listed in this section.
2. Operating and Maintenance Data.

PART 2 - PRODUCTS

2.1 THERMOMETERS, WATER

A. Acceptable Manufacturers:
1. Ashcroft, Weiss, Trerice, Marsh, Weksler, Tel-Tru.
2. Other Manufacturers: Submit Substitution Request.

B. Direct drive 4-1/2-inch dial type, stainless steel case, separable sockets, stem length to penetrate minimum of 1/2 pipe diameter, adjustable face, extension necks where required to clear insulation.

C. Range:

HVAC Systems	Temperature °F	Graduations (°F)
Chilled/Heating Water	30-180	2

2.2 PRESSURE GAUGES - GENERAL

A. Acceptable Manufacturers:
1. Marsh, Ashcroft, Weiss, Trerice, Weksler, Tel-Tru.
2. Other Manufacturers: Submit Substitution Request.

B. Description: 4-1/2-inch dial, molded black polypropylene turret case.

C. Range:

HVAC Systems	Pressure (psi)	Graduations (psi)
Chilled/Heating Water	0-100	1

2.3 DIFFERENTIAL PRESSURE GAUGES

A. Description: Surface mounted diaphragm-actuated dial type with zero pointer adjustment. Provide 4-inch minimum dial diameter with black figures on a white background.

B. Tubing: Copper; polytube may be used if concealed inside walls.

C. Manufacturer:
   1. Across Filters: Dwyer magnahelic Model 2002-AF, 0-2.0 inches of water range with air filter gauge accessory package.

2.4 WATER METER

A. Acceptable Manufacturers:
   1. Hersey, Badger, Sparling.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Disc type meter, bronze split casing, magnetic drive.
   2. Heavy duty gear train, completely sealed, circular meter, totalize in cubic feet with sweep hand.
   3. Comply with AWWA performance standards.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Provide meters and gauges where shown on Drawings.

B. Install all gauges and meters as required and as recommended by equipment manufacturer or their representative.

C. Extend all connections, wells, cocks, or gauges to a minimum of l-inch beyond insulation thickness of the various systems.

D. Locate all gauges so that they may be conveniently read at eye level or easily viewed and read from the floor or from the most likely viewing area, i.e., platform, catwalk, etc.

E. Install instruments over 6'-6" above floor, to be viewed from the floor, with face at 30 degrees to horizontal.

3.2 INSTALLATION - PRESSURE GAUGES

A. Provide instrument gauge cock at inlets. Provide protective siphon on steam gauges.

B. Locate pressure gauge taps for measuring pressure drop or increase across pumps, coils, condensers, etc., as close to the device as possible.

3.3 WATER METER

A. Installed in accord with manufacturer’s recommendations and as shown on the Drawings.

END OF SECTION

GENERAL DUTY VALVES AND SPECIALTIES FOR HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Valves, general purpose gauge cocks, and balance fittings.

1.3 SUBMITTALS

A. Submit product data.

A. Submit balancing valve schedule with manufacturer, model, size, flow rate and pressure drop.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER VALVES

A. General: Where only Nibco figure numbers are listed, equivalent products by those specified below are acceptable.
   1. Gate, Globe, Swing Check: Victaulic, Crane, Kennedy, Stockham, Milwaukee, Walworth and Hammond.
   2. Silent Check: Mueller, Metraflex, Victaulic, Bell and Gossett, Milwaukee and Gruvlok.
   3. Balancing: DeZurik, Homestead, Bell and Gossett, Armstrong, Walworth, Taco, Wheatley, Tour and Andersson, Victaulic, Gruvlok, Nibco, Nutech, Pro Hydronic.
   4. Butterfly: Victaulic, Gruvlok, Crane, Walworth, Milwaukee and Metraflex.
   5. Ball: Gruvlok, Apollo, Crane, Hammond, Milwaukee and Victaulic.

B. Other Manufacturers: Submit Substitution Request.

C. All such valves shall be of one manufacturer.

D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system. Refer to Section 23 21 13 for allowable fittings.

2.2 GATE VALVES

A. Iron Gate, OS&Y: Iron body, bronze trim, OS and Y pattern, solid wedge, 150 psi rating; Nibco 637.

2.3 GLOBE VALVES

A. Bronze Globe and Angle Globe: Bronze body, bronze mounted, renewable composition disc, 150 psi rating; Nibco 235 or 335.

B. Bronze Globe and Angle Globe High Pressure: Bronze body, stainless steel disc, union bonnet, 300 psi steam; Nibco 276-AP or 376-AP.

C. Iron Globe: Iron body, bronze mounted, OS and Y pattern, renewable composition disc, 125 psi rating; Nibco 718-B.

2.4 CHECK VALVES

A. Horizontal Bronze Swing Check: Bronze body, bronze mounted, regrinding bronze disc, 150 psi steam rating, 300 psi WOG; Nibco 433-Y.

B. Horizontal Iron Swing Check: Iron body, bronze mounted, regrinding bronze disc and seat ring, 125 psi rating; Nibco 918.

C. Vertical and Silent Check Valves:
   1. 250-lb. WOG, iron body, stainless steel trim, globe type with flanged ends; Nibco 960.
   2. 300-psig CWP, ductile iron body, stainless steel spring and shaft. Victaulic Series 716.
   3. 230-psig CWP, AGS grooved end ductile iron body, stainless steel spring, shaft, and disc, EPDM seat. Victaulic Series W715.

D. Vertical and Silent Check Valves: 250-lb. WOG, iron body, stainless steel trim, wafer type; Nibco W-960.

E. Iron Swing Check with Lever and Spring: Iron body, bronze fitted, with adjustable lever and spring; Nibco F-918-BL&S.

2.5 BALL VALVES

A. Bronze Ball: Bronze cast body or forged brass, chrome-plated full port ball, with handle, Teflon seat, 300 psi WOG, 150 psi steam; Nibco 585-70 or Victaulic Series 589.

2.6 BUTTERFLY VALVES

A. Ductile iron body, electroless-nickel chrome plated disc and stainless steel shaft (shaft shall be offset from the disc centerline to provide complete 360-degree circumferential seating), with lever handle and locking feature on valves 6-inches and less., gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, pressure responsive EPDM liner, 300 psi water; Victaulic MasterSeal, Nibco 2000, Nibco 4765.

B. Copper Grooved Piping System Butterfly Valve: Nylon coated or Cast bronze body per Copper Development Agency-836, ductile iron disc encapsulated with EPDM coating, lever handle up to 6-inches, gear operator on valves 8-inches and greater, stem length to accommodate insulation, 300 psi water; Victaulic Series 608, per ASTM A-584.
   1. Grooved ends shall be manufactured to copper-tubing sizes. Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.

2.7 BALANCING VALVE

A. Calibrated:
   1. Venturi style design. Valve to perform the following functions: Precision flow measurement, precision flow balancing, memory stops, positive shut-off to a minimum of 250 psi, drain port suitable for hose bibb fitting. Threaded or solder ends for 1/2-inch through 2-inches. 1/2-inch valve shall be capable of balance to 0.5 GPM. Grooved or flanged ends for 2-1/2-inches through 12-inches. Bell and Gosset, Flow Design, Griswold, Nutech, Pro Hydronic.
   2. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

2.8 SPECIALTY VALVES

A. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch; Conbraco 41 series.

B. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap and chain 3/4 inch size.

2.9 SYSTEM SPECIALTIES

A. Manual Air Vents: Coin type; Dole No. 9 or approved equal.

B. Automatic Air Vents:
   1. Acceptable Manufacturers:
      a. Spirotherm Spirotop.
      b. Other Manufacturers: Submit Substitution Request.
   2. Description: Water main type, cast brass body, built-in check valve, 1/8-inch I.P.S. top tapping for moisture discharge, 3/4-inch size, 150 psi operating pressure.

C. Pressure/Temperature Test Plug:
   1. Acceptable Manufacturers:
      a. Peterson Engineering, Inc., Universal Lancaster, Sisco, Trerice.
      b. Other Manufacturers: Submit Substitution Request.
   2. General: 1/2-inch N.P.T. fitting to receive either a temperature or pressure probe 1/8-inch O.D., fitted with a color coded and marked cap with gasket.
   3. Material: Solid brass with valve core of Nordel.
   4. Rating: Minimum 300 psig at 275°F.
   5. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch O.D. probe and two five-inch stem pocket test thermometers 25°-125°F for chilled water, 40°-240°F for heating water.

2.10 INTEGRATED COIL PIPING CONNECTOR

A. Acceptable Manufacturers: Flow Design, Griswold Controls, HCi, Pro Hydronic.

B. Components shall consist of full port forged brass isolation valves with integral union and pressure temperature port, strainer where indicated, flow meter, balance valve with memory stop, air vents, and drains.

C. Use of integrated flexible braided hoses is not acceptable.

D. Components shall be of same manufacturer as approved assembly supplier listed in this section or other approved manufacturers listed for each component in other sections of this specification.

E. Components shall meet the specifications for each component as listed on other sections of the specification.

F. Assembly shall be capable of continuous operation at 150 psi and system test pressure when installed in piping systems.

G. Assembly shall be the same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required, except the balancing valve may be a smaller size as required to balance the flow.

2.11 BLADDER EXPANSION TANK SYSTEM

A. Acceptable Manufacturers:
   1. Amtrol, Bell & Gossett, Armstrong, Wheatley, Taco.
   2. Other Manufacturers: Submit Substitution Request.

B. Expansion Tank: Bladder type of welded steel, constructed and stamped in accordance with ASME Code for 125 psi working pressure. Support with steel legs or bases for vertical installation or steel saddles for horizontal installation. Tank shall be precharged with compressed air to minimum fill pressures as indicated. Bladder shall be replaceable.

C. Size: ET-1, minimum 170 gallons, vertical tank as indicated.

2.12 AIR/DIRT SEPARATOR – HIGH EFFICIENCY COALESCING

A. Acceptable Manufacturers:
   1. Spirotherm "Spirovent" model VDT.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Turbulence suppressive type air eliminator to separate microbubbles and to remove stationary air pockets through absorption. Brass or steel body with centerlined inlet and outlet for in-line piping. Valved side tap to bleed large amounts of air during system fill.
   2. Spirotubing made of copper wire woven around central copper tube inside housing. Integrated brass venting mechanism on top. Blowdown connection port at bottom.
   3. Maximum working pressure, 150 psi. Maximum working temperature 270°F. Maximum allowable water velocity, 4ft/second. Maximum pressure drop 0.5 ft.
   4. Air elimination efficiency 0f 100% free air, 100% entrained air, 99.6% dissolved air.
   5. Dirt separation efficiency of 80% of particles 30 micron and larger with 100 passes.

2.13 PRESSURE REDUCING VALVE (CLOSED HYDRONIC SYSTEM FEED)

A. Acceptable Manufacturers:
   1. Bell & Gossett, Armstrong, Taco, Amtrol, Cash Acme.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Self-filling type with low inlet pressure check valve, removable strainer, adjustable range, and set point as indicated on the Drawings.

C. Construction: Iron body for steel piping installation, brass body for copper piping installation. All working parts shall be brass.

D. Size: 3/4-inch unless shown otherwise.

2.14 WATER RELIEF VALVES

A. Acceptable Manufacturers:
   1. Consolidated, Kunkle, B&G, Armstrong, Cash Acme.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Bronze or steel body, stainless steel or bronze, pressure settings to 160 psi at 250°F, conforming to Section IV of ASME Code, size per manufacturer's recommendations based on Code, setting as indicated; Kunkle Model 537.

2.15 STRAINERS

A. Acceptable Manufacturers:
   1. Nibco, Armstrong, McAlear, Sarco, Steamflo, Mueller, R.P. & C. Company Titan Flow Control.
   2. For Grooved Coupling Systems: Gruvlok or Victaulic.
   3. Other Manufacturers: Submit Substitution Request.

B. Wye Pattern:
   1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.
   2. Ductile Iron: Ductile iron body, 300 psi, 1/16 or 1/8-inch 304 stainless steel screen.
   3. Cast Iron: Cast iron body, 125 psi, 1/16-inch perforated type 304 stainless screen.
   4. Cast Iron, High Pressure: Cast iron body, 250 psi, 1/16-inch perforated type 304 stainless screen.

C. Basket Pattern: Semisteel body, 125 psi WOG, flanged, 1/8-inch perforated type 304 stainless steel screen, closed bottom basket, clamped or bolted cover.

2.16 SUCTION DIFFUSERS

A. Acceptable Manufacturers:
   1. Bell & Gossett, Armstrong, Taco, Amtrol, Wheatley, Paco, Mueller.
   2. For Grooved Piping Systems: Gruvlok or Victaulic.
   3. Other Manufacturers: Submit Substitution Request.

B. Description: Angle type body with inlet straightening vanes and combination orifice cylinder-diffuser-strainer with 3/16-inch diameter openings. Provide inlet vane length equal to 2-1/2 times pump connection diameter. Provide adjustable support foot to carry the weight of suction piping, drain plug, and pressure gauge tap.

C. Construction: Cast iron body rated for 175 psig operating pressure at 300°F. Provide steel inlet vanes on closed systems, stainless steel on open systems and domestic water systems. Provide steel orifice cylinders on closed systems, stainless steel on open systems and domestic water systems. Provide bronze mesh start-up strainers on closed systems and domestic water systems, none on open systems.

D. Selection: Outlet size shall match pump inlet size. Inlet size shall match pipe size upstream. Maximum of 2 psi drop without start-up strainer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide valves at connections to equipment where shown or required for equipment isolation.

B. Install all valves and strainers in accessible locations and same size as connected piping (not the size of the equipment connection), except balancing valves shall be sized by the contractor to properly balance the flow.

C. Provide separate support for valves where necessary.

D. Provide drain valves in all low points in the piping system, at coils and equipment, and as indicated.

3.2 APPLIED LOCATIONS HVAC VALVES

A. In piping 2-inches and smaller:

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Heating Water	Not Allowed	Bronze	Bronze	Bronze	Not Allowed

B. In piping 2-1/2-inches and larger:

System	Valve Types				
	Gate	Globe	Check	Ball	Butterfly
Chilled Water	Not allowed	Iron	Iron, Swing	Not Allowed	Ductile Iron
Heating Water	Iron (Boiler iso only)	Iron	Iron, Swing	Not Allowed	Ductile Iron
Pump Discharge	Not allowed.	Iron	Iron, Silent Check: Globe or Water Style, Swing with Lever and Weight or Lever and Spring	Not Allowed	Ductile Iron

C. Calibrated venturi balancing valves 1/2-inch through 12-inches, on water coils and in piping systems in accordance with manufacturer's recommendations.

D. Provide gauge cock for all pressure gauges.

E. Provide gate valves with pressure type packing glands for heating water boiler shutoff applications. Valves shall meet requirements of ASME Boiler and Pressure Vessel Code, Section IV, Article 7 for Stop Valves.

3.3 VALVE IDENTIFICATION

A. General: Identify valves to indicate their function and system served.

B. See Section 23 05 53, Identification for HVAC Piping and Equipment.

3.4 CHAIN OPERATORS

A. All valves in equipment rooms or fan rooms used for equipment or coil isolation and more than 8 feet above floor shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6 feet above floor.

3.5 INSTALLATION

A. Manual Air Vents:
   1. Install at all high points where automatic air vents are not used, where noted, and where required for proper venting of system.
   2. Install in accordance with manufacturer's recommendations.

B. Automatic Air Vents:
   1. Install automatic air vents at high points where air can collect in water systems where indicated. Route drain lines from vent to nearest floor drain.
   2. Install 3/4-inch globe shut-off valve ahead of air vent. Install ball valve where bucket drainage is required.

C. Grooved Mechanical Pipe Valve End Connections:
   1. Refer to specification 23 21 13 for allowed service installations.
   2. Shall be installed in accordance with the manufacturer's published installation instructions.
   3. Gaskets shall be molded and produced by the coupling manufacturer, and shall be suitable for the intended service.
   4. The coupling manufacturer's factory trained representative:
      a. Shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products.
      b. Shall periodically visit the project site to ensure best practices in grooved installation are being followed.
      c. A distributor's representative is not considered qualified to conduct the training or field visits.

D. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.

E. Coil Connectors:
   1. Applied Locations: Integrated coil connectors are prohibited except where specifically indicated below or on the drawings.
   2. Make all connections in accordance with Section 23 21 13, Pipe and Pipe Fittings HVAC.

F. Expansion Tanks:
   1. Support with steel rods and brackets from structure or from structural steel stand as required.
   2. Pipe valve drain to over floor drain.

G. Air Separator:
   1. Install as shown on Drawings and in accordance with the manufacturer's recommendations.
   2. Suspend from structure with steel rods or brackets or support from steel stand as required.
   3. Bleed system air at start-up according to manufacturer's recommendations.

H. Pressure Reducing Valves:
   1. Install where indicated and in accordance with manufacturer's recommendations with 3 valve bypass.

I. Water Relief Valves:
   1. Install where indicated, and in accordance with manufacturer's instructions. Pipe discharge to nearest floor drain using Schedule 40 steel pipe.

J. Strainer:
   1. Provide valved blow off for each strainer of same size as plugs with maximum size of 1-1/2 inches. Pipe blow off full size and terminate over floor drains except finned tube, reheat coils, fan coils, terminal units, and unit heaters.
   2. Applied Locations HVAC:
      a. Cast iron wye, chilled, heating water.
      b. Bronze wye, in piping 2-inch and smaller..
      c. Basket, in piping 2-1/2-inch and larger.

K. Suction Diffusers:
   1. Install on inlets of pumps where indicated in accordance with manufacturer's recommendations.
   2. Support suction diffuser and piping from same surface as pump base is supported unless shown otherwise. Adjust foot so that pump inlet does not carry any piping weight.
   3. Pipe pressure gauges to gauge port, and blow down to drain with ball shut-off valve.
   4. After operating pumps for seven days, clean strainer and remove start-up strainer.

END OF SECTION

HANGERS, SUPPORTS AND ANCHORS FOR HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Supports and anchors for piping systems and equipment.

B. Related Sections include:
1. Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.
2. Section 23 07 00 Insulation for HVAC.
3. Section 23 21 13 Pipe and Pipe Fittings HVAC.

1.3 QUALITY ASSURANCE

A. Provide pipe and equipment hangers and supports in accordance with the following:
1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
3. Seismic restraint shall not introduce excessive stresses in the piping caused by thermal expansion or contraction.
4. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
5. Seismic restraints shall be in accordance with the latest edition of the SMACNA “Seismic Restraint Manual - Guidelines for Mechanical Systems” for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
6. Seismic restraints shall be in accordance with the applicable code.
7. Seismic restraints shall follow the provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

B. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.
1. Supports and seismic restraints for suspended piping and equipment.
2. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
3. Equipment and piping support frame anchorage to supporting slab or structure.

1.4 SUBMITTALS

A. Submit the following:
1. Shop Drawings of contractor fabricated support structures.
2. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
3. No other submittals required under this section.

PART 2 - PRODUCTS

2.1 SUPPORTS, GENERAL

A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.

B. Acceptable Manufacturers: Unistrut, Superstrut, Powerstrut and Kinline, B-Line Systems, AnvilStrut.

C. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.

D. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.

E. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.2 PIPE ATTACHMENTS

A. Acceptable Manufacturers: Anvil as noted or equivalent products by Superstrut, B-Line Systems, Tolco, Michigan Hanger.

B. Uninsulated Horizontal Copper Piping:
   1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.
   2. Larger than 2-inch: Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods. Electricians' tape is unacceptable.

C. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.

D. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

E. Other Uninsulated Horizontal Pipe:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

F. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.
   2. Larger than 2-inch: Anvil 260.

G. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

H. Riser Clamps Copper Pipe:
   1. 4-inch and Smaller: Anvil CT-121, CT-121C or 261C.
   2. Larger than 4-inch: Anvil 261C.

I. Riser Clamps Other Piping: Anvil 261.

2.3 PIPE ROLLERS, INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

A. Acceptable Manufacturers: Anvil as noted or equivalent Super Strut, B-Line Systems, Tolco, Michigan Hangers.

B. Pipe Rollers: Anvil 174 or 274 as required. Size for pipe plus insulation for insulated pipe.

C. Insulation Protection Shields: Anvil 167.

D. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory or field copper plated.

2.4 BUILDING ATTACHMENTS

A. Acceptable Manufacturers: Anvil as listed or equivalent products by Elcen, Superstrut, B-Line Systems, Tolco, Michigan Hangers.

B. Beam Hangers:
   1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.
   2. On piping larger than 6-inch: Anvil 228, or 292.

C. Inserts: Anvil 152 malleable iron or 281 steel inserts. Inserts sized for required rod to support load being carried.

D. Expansion Plugs: Similar and equal to Phillips “red-head” self-drilling flush shell selected for safety factor of 4.

E. Powder actuated fasteners with silencers as approved by Architect.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General:
   1. Install all support systems as detailed and in accordance with manufacturer’s recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required and as detailed on the Drawings.
   2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
   3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
   4. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
   5. Support all piping within 2 feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:
   1. See Section 23 07 00 for insulation requirements.
   2. Insulated Piping Systems with Vapor Barrier Insulation:
      a. Install hangers outside of insulation.
      b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.
   3. Heating Water (over 230°F), Medium Pressure Steam and High Pressure Steam (Non-Vapor Barrier Insulation):
      a. As specified for Insulated Piping Systems with Vapor Barrier Insulation.
   4. Other insulated Piping Systems with Non-Vapor Barrier Insulation:
      a. At the contractor’s option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
      b. If hangers are installed outside of insulation, provide insulation protection shields at all support locations on piping 1-1/2-inch and larger.
      c. On piping larger than 2-inch, provide insulation saddles at each support location.

C. Vertical Piping:
   1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
   2. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.

3. Risers that are not subject to thermal change to be supported at each floor of penetration.
4. Risers that are subject to thermal change require engineered supports. Size supports to carry all forces exerted by piping system when in operation. Riser supports shall follow the provisions described in Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Horizontal Piping:
1. Trapeze Hangers: Multiple pipe runs where indicated shall be supported on channels with rust resistant finish. Provide all necessary rods and supporting steel.
2. Support Spacing: Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:
   a. Support piping within 2 feet of each change in direction.
   b. Steel Pipe, Copper Tubing:

Minimum Pipe Size	Max. Span Steel	Max. Span Copper	Rod Size
1-inch and smaller	7 feet	5 feet	1/4-inch
1-1/4-inch to 2-inch	8 feet	8 feet	3/8-inch
2-1/2-inch to 3-inch	11 feet	9 feet	1/2-inch
4-inch to 5-inch	14 feet	12 feet	1/2-inch
6-inch	17 feet	14 feet	1/2-inch

   c. Plastic Pipe: Supported a maximum of 3 feet on center for piping 1-inch and smaller and 4 feet on center for piping 1-1/4-inch and larger with rod sizes as recommended by the manufacturer.
   d. Piping provided with acoustical lagging wrap shall be supported a maximum of 5 feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:
1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support all piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
2. Provide horizontal bracing on all horizontal runs 1-1/2 inch and larger and exceeding 50 feet in length at 75 foot intervals and as required to provide stabilized piping systems.
3. Provide all additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Isolation of mechanical equipment as indicated on the Drawings and specified herein.
   2. Seismic restraint of equipment, piping and ductwork.

B. Related Sections include:
   1. Section 23 05 18 HVAC Expansion Compensation.
   2. Section 23 05 29 Hangers, Supports and Anchors for HVAC.
   3. Section 23 31 01 HVAC Ducts and Casing-Low Pressure.

1.3 QUALITY ASSURANCE

A. A single manufacturer shall select and furnish all isolation required, except packaged equipment with integral isolators meeting all the isolation and seismic requirements of this specification.

B. The system of vibration isolators and seismic controls shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.

C. Isolation performance requirements are indicated in the specifications. All deflections indicated are nominal static deflections for specific equipment supported.

D. Isolator Stability and Rated Capacity:
   1. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.
   2. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

E. Seismic Restraints:
   1. Restraint of equipment, piping and ductwork to be in accordance with the current state and local Building Code.
   2. All calculations shall be in accordance with current state and local Building Code.

1.4 SUBMITTALS

A. Submit the following:
   1. Submit Shop Drawings showing complete details of construction for steel and concrete bases including:
      a. Equipment mounting holes.
      b. Dimensions.
      c. Isolation selected for each support point.
      d. Details of mounting brackets for isolator.
      e. Weight distribution for each isolator.
      f. Code number assigned to each isolator.
   2. Submit product data and calculation sheets for isolators, showing:
      a. Size, type, load rating and rated deflection of each required isolator.
      b. Percent of vibration transmitted based on the lowest disturbing frequency of the equipment.
   3. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.

B. Installation report as specified in Part 3 of this section.

C. Operation and maintenance data.

1.5 EQUIPMENT VIBRATION ISOLATION

A. Provide a balanced set of vibration isolators for each piece of equipment listed in the Equipment Schedules.

B. Isolation work to include, but not necessarily be limited to, the following:
   1. Isolation support of motor-driven equipment.
   2. Inertia base frames in conjunction with isolation.
   3. Isolation support of air-handling housings.
   4. Isolation support of piping, piping risers, and ductwork.
   5. Penetration isolation of pipework, ductwork, and conduits through walls, floors or ceilings.
   6. Flexible connections of ductwork and piping to equipment.

C. Each piece of rotating equipment must meet a reasonable criterion for maximum vibration levels at each bearing, while in operation. The criteria for varying operating speeds are given as follows:
   1. Rotating equipment operating peak vibration velocities must not exceed 0.08 in./sec.
   2. If it is discovered that the operating vibration velocities exceed this criteria, the equipment shall be repaired or replaced at no expense to the owner until approval of the equipment is given by the engineer.

D. Any components or materials not specially mentioned herein, but necessary to the proper vibration isolation of the equipment, shall be provided.

1.6 ACCEPTABLE MANUFACTURERS

A. Amber Booth.

B. Mason Industries, Inc.

C. Kinetics Corporation.

D. Vibrex.

E. Vibro-Acoustics

F. Approved equal, meeting all of the conditions and requirements specified herein.

1.7 CONTRACTOR RESPONSIBILITY

A. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or suppliers.

B. Adequately restrain all equipment, piping, and ductwork to resist seismic forces. Design and select restraint devices to meet seismic requirements as defined in the latest issue of the International Building Code under Earthquake Design and applicable state and local codes.

C. In addition, the contractor shall have the following responsibilities:
   1. Selection, installation, adjustment and performance of vibration isolators which will meet the requirements given on the plans or in the specifications.
   2. Provide Engineering drawings, details, supervision, and instruction to assure proper installation and performance.
   3. Provide whatever assistance necessary to ensure correct installation and adjustment of the isolators.

PART 2 - PRODUCTS

2.1 TYPE 1 - NEOPRENE WAFFLE PAD

A. 3/4-inch thick neoprene waffle pads with pattern repeating on 1/2-inch centers.

B. Select Duro rating for maximum deflection at average load rating.

C. Include load distribution steel plate as required.

D. Include anchor bolt grommet as required.

E. Acceptable Manufacturer: Mason Type “Super W” or “Super WM” and “HG Grommet”; Similar Amber-Booth, Kinetics Corporation.

2.2 TYPE 2 - RESTRAINED NEOPRENE MOUNT

A. Bridge-bearing neoprene mountings shall have all directional seismic capability.

B. Provide minimum deflection of 0.2-inch.

C. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements.

D. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation.

E. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.

F. Manufacturer: Mason type BR.

2.3 TYPE 3 - SPRINGS

A. Free standing springs without housings.

B. 1/4-inch thick molded neoprene cup with steel reinforcement washer or neoprene acoustical friction pads between base plate and support.

C. All mounting shall have leveling bolts with height saving brackets.

D. Springs mounted outboard of channels.

E. Attach baseplate screws using neoprene bushings and washers.

F. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.

G. Manufacturer: Mason type SLF, Amber-Booth type SW, Kinetics Corporation, Vibrex.

2.4 TYPE 4 - SPRINGS WITH RESTRAINTS

A. Same as springs except housing with seismic restraints to be added.

B. Seismic restraint with molded all directional neoprene bushings an integral part of isolator.

C. Seismic restraint selected for minimum safety factor of 2 from ultimate seismic capacity.

D. Spring mount must have neoprene cup or pad inside the seismic housing to allow anchoring of the housing baseplate without short circuiting pad.

E. Manufacturer: Mason type SSLR or SLRS with seismic restraints; similar Amber-Booth, Kinetics Corporation Model FYS, Vibrex.

2.5 TYPE 5 - BASE WITH SPRINGS

A. Steel Isolating Frame: Mason WFSL with WF steel beams with a minimum depth of 10% of the span between supports. Provide external height saving brackets.

B. Manufacturer: Mason as indicated, similar Amber-Booth, Kinetics Corporation, Vibrex.

2.6 TYPE 6 – INERTIA BASE WITH SPRINGS

A. Inertia Bases: Mason BMK or KSL with 1/2-inch square bar reinforcing, integral height saving brackets and steel templates with anchor bolts sleeves. Bases must be sized to fit stanchions for pump elbows or suction diffusers. Depth of base equal to 8% of the span between supports, 6-inch minimum.

B. Manufacturer: Mason as indicated, similar Amber-Booth, Kinetics Corporation, Vibrex.

2.7 TYPE 7 - ISOLATING SPRING HANGERS

A. Combination rubber-in shear and steel spring isolators installed on the hanger rods.

B. Isolators shall have the proper deflection to allow the piping to deflect as a unit with the pump isolators.

C. Hangers designed for 30 degree angular movement.

D. Minimum deflection shall be one inch.

E. Manufacturer: Mason 30N, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.8 TYPE 8 – ISOLATING NEOPRENE HANGERS

A. Double deflection neoprene hangers.

B. Provide minimum static deflection of 0.5-inches.

C. Provide projecting bushing to prevent steel to steel contact.

D. Manufacturer: Mason HD, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.9 ISOLATING SLEEVES

A. Provided for all piping through walls and floors of penthouses and chiller room. Size for piping as required.

B. Manufacturers: Potter-Roemer PR isolators or Grinnell Semco Trisolators.

2.10 SEISMIC RESTRAINTS

A. General Requirements:
   1. Seismic restraints shall be provided for all equipment, piping and ductwork, both supported and suspended.
   2. Bracing of piping and ductwork shall be in accordance with the code and with the provisions set forth in the SMACNA seismic restraint manual.
   3. The structural requirements for the restraints, including their attachment to the building structure, shall be reviewed and approved by the structural engineer.
   4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Supported Equipment:
   1. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.
   2. Bushing shall be replaceable and a minimum of 1/4-inch thick. Rated loadings shall not exceed 1000 psi.
   3. An air gap of 1/4-inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces.
   4. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to ensure no short circuits exist before systems are activated.
   5. Snubber shall be type Z-1225 as manufactured by Mason Industries, Inc.

C. Bracing of Pipes:
   1. Provide seismic bracing of all piping as detailed below to meet the building code requirements:
      a. Exception: Piping suspended by individual hanger's 12-inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be braced where the following criteria are met.
         1) Seismic braces are not required on high deformability piping when the Ip=1.0 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 3-inches diameter or less.
         2) Seismic braces are not required on high deformability piping when the Ip=1.5 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 1-inch diameter or less.
   2. Seismic braces for pipes on trapeze hangers may be used.
   3. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints, or where pipes connect to equipment.
   4. Cast iron pipe of all types, glass pipe, and any other pipe jointed with a shield and clamp assembly, where the top of the pipe is 12-inches or more from the supporting structure, shall be braced on each side of a change in direction of 90 degrees or more. Riser joints on unsupported sections of piping shall be braced or stabilized between floors.
   5. Vertical risers shall be laterally supported with a riser clamp at each floor. For buildings greater than six stories high or for piping subject to thermal change all risers shall be engineered individually.

D. Bracing of Ductwork:
   1. Brace rectangular ducts with cross sectional areas of 6 square feet and larger. Brace flat oval ducts in the same manner as rectangular ducts. Brace round ducts with diameters of 28 inches and larger. Brace flat oval ducts the same as rectangular ducts of the same nominal size.
   2. Exception: No bracing is required if the duct is suspended by hangers 12 inches or less in length, as measured from the top of the duct to the bottom of the support where the hanger is attached, and the Ip=1.0.
   3. Transverse bracing shall occur at the interval specified in the SMACNA tables or at both ends if the duct run is less than the specified interval. Transverse bracing shall be installed at each duct turn and at each end of a duct run, with a minimum of one brace at each end.
   4. Longitudinal bracing shall occur at the interval specified in the SMACNA tables with at least one brace per duct run. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it if the bracing is installed within four feet of the intersection of the ducts and if the bracing is sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
   5. Install duct flex connections at equipment connections to accept expected differential displacement and protect the equipment connection from damage.

E. Suspended Equipment and Piping and Ductwork:
   1. Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
   2. Cable must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
   3. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.

4. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be type SRC or UC as manufactured by Mason Industries, Inc.
5. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

2.11 FLEXIBLE SPHERE CONNECTOR

A. Flexible EPDM pipe connectors shall be manufactured of multiple plies of Kevlar tire cord fabric and EPDM; both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement.

B. Connectors up to and including 2-inch diameter may have a single sphere and threaded ends. Connectors 2-1/2-inch and larger shall be manufactured with twin spheres up to 12-inches and a single sphere on larger sizes and floating steel flanges recessed to lock the connectors raised face EPDM flanges.

C. All connectors shall be rated a minimum of 150 psi at 220°F. All connections shall be pre-extended as recommended by the manufacturer to prevent additional elongation under pressure.

D. Mason type SFU, SFDEJ or SFEJ.

2.12 FLEXIBLE HOSE CONNECTOR

A. Flexible stainless steel hoses shall be manufactured using type 304 stainless steel hose and braid with one fixed and one floating raised face carbon steel plate flange.

B. Sizes 2-1/2-inch (65mm) and smaller may have threaded male nipples or copper sweat ends. Grooved ends are acceptable in all sizes in grooved piping systems. Weld ends are not acceptable. Copper sweat end hoses for water service shall be all copper or bronze construction.

C. Hose shall have close pitch annular corrugations for maximum flexibility and low stiffness. Tested hose stiffness at various pressures must be included in the submittals.

D. Hose shall be capable of continuous operation at 150 psi and system test pressure when installed in piping systems.

E. Hose shall be the same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required.

F. Mason type BSS, FFL, MN, CPS or CPSB, similar HCi, Metraflex.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not install any equipment or pipe which makes rigid contact with the building. "Building" includes slabs, beams, studs, walls, etc.

B. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.

C. Correct, at no additional cost, all installations which are defective in workmanship or materials.

3.2 PREPARATION

A. Treat all isolators, including springs, hardware and housing, with a corrosion protective coating of epoxy powder or electro galvanizing.

B. Coat steel frames exposed to weather with a rustproof metal primer.

C. Provide hot dipped galvanizing on steel frames as indicated on the plans for corrosion protection in severe conditions.

3.3 INSTALLATION

A. General:
   1. Install isolation where indicated on the Drawings by type and location and where indicated below.
   2. The assigned code number shall be marked on the isolators and bases to assure placement in the proper location.
   3. Anchor isolator seismic housing baseplate to floor.
   4. Rubber grommets and washers shall be provided to isolate the bolt from the building structure. Under no circumstances shall the isolation efficiency be destroyed when bolting the isolators to the building structure.

B. Type 1 – Neoprene Waffle Pad
   1. Service:
      a. Roof-mounted exhaust fans
      b. Air Handlers and Fan Coil Units with Motors two horsepower and less.
      c. Condensing units

C. Type 4 – Springs with Restraints
   1. Service:
      a. Exhaust fans where floor mounted
      b. Air Handlers fans with Motors greater than 2 horsepower – one inch static deflection

D. Type 6 – Inertia Base with Springs
   1. Service:
      a. Centrifugal Pumps
         1) Fill with concrete to provide base weight equal to 2 times supported weight, including equipment, piping, and fluid.
         2) Support heels of pump suction and discharge elbows from base.
         3) Secure pump and heel supports with inserts and grout.
         4) Springs to have min 1” deflection

E. Type 7 – Isolating Spring Hangers
   1. Service:
      a. Propeller Fans
      b. Exhaust fans with motors larger than ½ horsepower.

F. Type 8 – Isolating Neoprene Hanger
   1. Service:
      a. In-Line Circulating Pumps
      b. Split-System Air Conditioning Units
      c. Exhaust fans with motors ½ horsepower and smaller.

G. Flexible Connectors:
   1. Mechanical Couplings: Provide three or more flexible couplings as vibration isolation as indicated on the drawings and for the following services:
   2. Flexible Sphere Connectors: Provide as indicated on the drawings and for the following services**:** Base-mounted pumps, deflection as scheduled.
   3. Flexible Hose Connectors: Provide as indicated on the drawings and for the following services: Air handling unit coil connections.

3.4 SEISMIC RESTRAINTS

A. General:
   1. Install and adjust seismic restraints so that the equipment, piping, and ductwork support is not degraded by the restraints.
   2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment:
   1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
   2. Care must be taken so that the 1/4-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

C. Bracing of Pipes:
   1. Branch lines may not be used to brace main lines.
   2. Transverse bracing shall be at 40 feet maximum, except where a lesser spacing is indicated in the SMACNA tables for bracing of pipes
   3. Longitudinal bracing shall be at 80 feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity to resist both the seismic load and the additional force induced by expansion and contraction.
   4. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
   5. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24 inches of the elbow or tee.
   6. Subject to confirmation by field inspection, seismic bracing is not required on piping when the piping is supported by rod hangers and the hangers in the entire run are 12-inches or less in length from the top of the pipe to the supporting structure, hangers are detailed to avoid bending of the hangers and their attachments and provisions are made for piping to accommodate expected deflections.

D. Bracing of Ductwork:
   1. Hanger straps must be positively attached to the duct within 2 inches of the top of the duct with a minimum of two #10 sheetmetal screws.
   2. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
   3. Walls, including gypsum board nonbearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide solid blocking around duct penetrations at stud wall construction.
   4. Unbraced ducts shall be installed with a 6-inch minimum clearance to vertical ceiling hanger wires.

E. Suspended Equipment, Piping, and Ductwork Cable Method:
   1. The cables shall be adjusted to a degree of slackness approved by the Structural Engineer.
   2. The uplift and downward restraint nuts and Mason type RW neoprene covered steel rebound washers for the Type 6 hangers shall be adjusted so that there is a maximum 1/4-inch clearance.

3.5 FIELD QUALITY CONTROL

A. Installation Report: Isolation manufacturer's representative shall confirm that all isolation is installed correctly and submit report stating that isolators are installed as shown on Shop Drawings, isolators are free to work properly, and that installed deflections are as scheduled and as specified.

END OF SECTION

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IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Identify valves, piping and equipment components of the mechanical systems to indicate their function and system served.

1.3 SUBMITTALS

A. Submit the following:
   1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
   2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
   3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 - PRODUCTS

2.1 VALVE IDENTIFICATION

A. Valve Tags:
   1. General: Identify valves with metal tags, legends to be stamped or embossed. It shall indicate the function of the valve and its normal operating position; i.e.,

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)

   2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
   3. Material: Use 0.050 or 0.064-inch brass tags.
   4. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, “lamicoid” or equal. Form letters by exposing center ply.

B. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.2 PIPING MARKERS

A. Acceptable Manufacturers:
   1. W.H. Brady, Seton, Marking Systems, Inc. (MSI).
   2. Other Manufacturers: Submit Substitution Request.

B. Pipes shall be labeled with all-vinyl, self-sticking labels or letters. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters. The pipe markers shall be identified and color coded as follows with black directional arrows.

HVAC SERVICE	BACKGROUND PIPE MARKER *	COLOR
HEATING/CHILLED WATER	”HTG/CH WATER SUPPLY”	GREEN
	”HTG/CH WATER RETURN”	GREEN
REFRIGERANT SUCTION	“REFRIGERANT SUCTION”	YELLOW
REFRIGERANT LIQUID	“REFRIGERANT LIQUID”	GREEN
REFRIGERANT HOT GAS	“REFRIGERANT HOT GAS”	YELLOW
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		

2.3 EQUIPMENT IDENTIFICATION

A. Nameplates:
   1. Tag all pumps, air handling supply units, fans, terminal units, and miscellaneous items of mechanical equipment with engraved nameplates. Nameplates shall be 1/16-inch thick, 3 x 5 laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
   2. Identify unit with equipment tag as shown on Drawings and area served.
   3. Access points to fire dampers, smoke dampers, and combination fire and smoke dampers shall be permanently identified on the exterior of the duct by a label with letters 1/2-inch in height reading: Fire Damper, Smoke Damper, or Fire/Smoke Damper, as appropriate. Label constructed from same material as equipment nameplates.

B. Equipment Nameplate Directory: List pumps, air handlers, terminal units, and other equipment nameplates. Include Owner and Contractor furnished equipment. List nameplate designation, manufacturer’s model number, location of equipment, area served or function, disconnect location, and normal position of HOA switch.

PART 3 - EXECUTION

3.1 VALVE IDENTIFICATION

A. Valve Tags:
   1. Attach to valve with a brass chain.
   2. Valve tag numbers shall be continuous throughout the building for each system.

B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.2 PIPING MARKERS

A. Unless recommendations of ANSI A13.1, 1981 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
   1. Every 20 feet along continuous exposed lines.
   2. Every 10 feet along continuous concealed lines.
   3. Adjacent to each valve and stubout for future.
   4. Where pipe passes through a wall, into and out of concealed spaces.
   5. On each riser.
   6. On each leg of a “T”.
   7. Locate conspicuously where visible.

B. Further, apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

3.3 EQUIPMENT IDENTIFICATION

A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

END OF SECTION

PRESSURE TESTING FOR HVAC SYSTEMS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Pressure testing of piping and ductwork systems.

1.3 QUALITY ASSURANCE

A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.

B. Owner Witness: Perform all tests in the presence of the Owner's representative.

C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe all tests or selected tests to assure compliance with the specifications.

D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's representative and the Engineer's representative need not occur simultaneously.

1.4 SUBMITTALS

A. Submit the following:
   1. Test Reports:
      a. Submit certificate of completion, inspection and test by authority having jurisdiction on required piping systems.
      b. Submit certificate of test approval by Owner's representative on all systems.
      c. For ductwork testing, submit the Test Report. Test Report shall contain description of the testing procedure and results, including recommendation for any remedial actions needed. The Engineer's representative will record witnessed tests.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL

A. Piping: Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties. Conduct tests with all valves but those used to isolate the test section 10% closed.

B. Ductwork: Test prior to connection to equipment and before applying insulation.

C. Leaks: Repair all leaks and retest until stipulated results are achieved.

D. Notification: Advise the Construction Manager 72 hours in advance of each test. Failure to so notify will require test to be rescheduled.

E. Testing Equipment: Provide all necessary pumps, gauges, connections and similar items required to perform the tests.

3.2 TESTING REQUIREMENTS

A. Low Pressure Ductwork:
   1. Test all ductwork systems at 2-inch static pressure, using a Pacific Air Products "Port-O-Lab" or "Rolok", or a McGill Airflow “LEAK DETECTIVE” testing machine or approved equivalent.
   2. All ductwork testing shall be conducted in accordance with latest published version of the SMACNA “HVAC Air Duct Leakage Test Manual”.
   3. Prior to testing verify that all low pressure ductwork has been sealed to meet the SMACNA Seal Class C. for all joints.
   4. Low pressure ductwork leakage shall be less than or meet the requirement of the following SMACNA Leakage Classes:
      a. Rectangular Metal – Class 24
      b. Round or Flat Oval – Class 12
   5. Maximum allowable leakage is defined as Cubic Feet per Minute (CFM) air leakage per 100 square feet SURFACE AREA of duct section tested.
   6. All low pressure ductworks shall be tested.

B. Piping - General: Test all piping as noted below, with no leaks or loss in pressure for time indicated. Repair or replace defective piping until tests are completed successfully:

HVAC Systems	Test Pressure	Test Medium	Test Duration
Heating/Chilled Water	150 psig	Water	4 hours
Refrigerant piping	300 psig	Nitrogen	4 hours

END OF SECTION

TESTING, ADJUSTING AND BALANCING

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Testing and balancing of air systems.
   2. Testing and balancing of hydronic systems.
   3. Testing and balancing of miscellaneous mechanical equipment.

1.3 QUALITY ASSURANCE

A. Acceptable Testing and Balancing Firms:
   1. A.I.R., Inc.
   2. Air Balance Specialty, Inc.
   3. Neudorfer Engineers, Inc.
   4. Northwest Engineering Services.
   5. Pacific Coast Air Balance.
   6. Accurate Balancing Agency, Inc.

B. Other Firms: Submit Substitution Requests prior to Bid Date.
   1. Certification: The firm shall be certified by National Environmental Balancing Bureau (NEBB).

C. Industrial Standards: Testing and Balancing shall conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
   1. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
   2. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
   3. ANSI:
      a. S1.4 Specifications for sound level meters.
      b. S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.

D. Instrument Certification: All instruments used shall be accurately calibrated and certified within six months of balancing and maintained in good working order.

E. Test Observation: If requested, the tests shall be conducted in the presence of the Architect or the Architect’s representative.

F. Pre-Balancing Conference: Prior to starting balancing, general techniques shall be reviewed with the Engineer. This conference must occur prior to measuring existing conditions. Measuring of existing conditions must occur prior to any demolition or new work. The conference will review existing conditions and systems to be affected by the project

1.4 SUBMITTALS

A. Submit the following:
   1. Balancing Log: Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes. Provide drawings identifying location of all outlets.
   2. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
   3. Additional Data: Submit all additional data as provided by Associated Air Balance Council (AABC) Standard forms.
   4. Number of Copies: Submit six (6) copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
   5. Instrument Certification: When requested, submit certificate of calibration for all equipment to be used.

B. Record data on NEBB forms or forms approved by the Architect.

1.5 PROJECT CONDITIONS

A. Do not perform final testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and operating continuously as required.

B. Conduct air testing and balancing with clean filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.6 WARRANTIES

A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Balance to maximum measured flow. Deviation from specified values of ±10 percent at terminal device and ±5 percent at equipment, or mean sound level deviation of 15 decibels. Advise Engineer if deficiencies are generally noted to enable proper corrective actions.

3.2 AIR SYSTEMS

A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
   1. Identify and list size, type, and manufacture of all equipment to be tested including air outlets and inlets.
   2. Use manufacturer's ratings for equipment to make required calculations except where field test shows ratings to be impractical.

C. Central System:
   1. Set speed to provide air volume at farthest run without excess static pressure. Provide additional sheaves and belts as required to accomplish speed adjustment.
   2. Read and adjust air supply, return, and exhaust fan units to deliver design conditions at minimum O.S.A. and at 100% O.S.A.
   3. Adjust all automatic dampers, outside air, return air, and exhaust dampers for design conditions.
   4. Read static air pressure conditions on all air handling equipment including filter and coil pressure drops and total pressure across the fan. A Dwyer Series 400 air velocity meter only shall be used for final static pressures at equipment and where critical readings are required.

5. Measure temperature conditions across all outside air, return air, and exhaust dampers to check leakage.
6. Read and record motor data and amperage draw.
7. For variable volume systems, establish minimum static pressure required at sensing point to permit operation over entire VAV range. Adjust supply and return fan speed so that at maximum demand the associated VFD is controlling the motor of motor nameplate RPM to 100%. Adjust return fan speed so that return air volumes track with supply air volume minus exhaust air volume.
8. Assist controls contractor in establishing minimum outside air damper positions.

D. Distribution:
1. Evaluate all building and room pressure conditions to determine adequate supply and return air conditions. Generally, the building shall be balanced to be slightly positive to outdoors.
2. Evaluate all building and room pressure conditions to determine adequate performance of the system to maintain temperatures without draft.
3. Perform multipoint pitot traverses to confirm instrumentation, shaft tightness, fan operation, etc. Pitot traverses shall be performed using a Dwyer Series 400 air velocity meter only with applicable duct probe.
4. Mark all balancing dampers.

E. Fire Life Safety Systems:
1. Balance, adjust, and test the stair and elevator pressurization components in order to pass the city test as described in Section 23 09 00, Instrumentation and Controls for HVAC. The balancer shall rebalance the system as necessary until it passes the city tests.

3.3 HYDRONIC SYSTEMS

A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
1. List complete data of tested equipment and verify against Contract Documents.
2. Open all line valves to full open position, close coil by-pass stop valves, then set mixing control valve to full coil flow.
3. For each pump:
   a. Verify rotation.
   b. Test and record pump shut-off head.
   c. Test and record pump wide-open head.
4. Verify proper system pressures.
5. Verify air vents in high points of water are properly installed and operating freely.

C. Central Equipment:
1. Check all conditions at all coils for required performance at design conditions.
2. Check conditions at all primary source equipment for performance of design conditions.
3. Read and record pump heads, motor data, and amperage draw.

D. Distribution:
1. Read and adjust water flow for design conditions.
2. Set all memory stops and mark position of adjuster on balancing valves.

3.4 ELECTRIC HEATING EQUIPMENT

A. Test and record voltage and amperage readings at each electric heating device while fully energized and at part load conditions (each step) to verify proper operation.

B. Record data on appropriate forms.

3.5 AUTOMATIC CONTROL SYSTEM

A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Testing organization shall verify all controls for proper calibration and list controls requiring adjustment by control system installer.

3.6 COORDINATION

A. Coordinate work with other trades to ensure rapid completion of the project.

B. Deficiencies noted during the course of air balancing in the mechanical installation shall be promptly reported to the Architect to allow corrective action to proceed.

C. Periodic review of progress shall be provided as requested.

END OF SECTION

INSULATION FOR HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Insulation for piping, ductwork (external), ductwork (internal), and equipment.

B. Related Sections include:
   1. Section 23 05 29 Hangers, Supports and Anchors for HVAC.
   2. Section 23 31 01 HVAC Ducts and Casing – Low Pressure.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All insulating products shall comply with the Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
   2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723.
   3. Energy Codes: Local Building and Energy Codes shall govern where insulation performance requirements for thickness exceeds thickness specified.

B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.

C. Source Quality Control:
   1. Service: Use insulation specifically manufactured for service specified.
   2. Labeling: Insulation labeled or stamped with brand name and number.
   3. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping, or ductwork, and shall be asbestos free.

1.4 SUBMITTALS

A. Submit the following.
   1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Equivalent products by Johns Manville, Knauf, Owens Corning, and CertainTeed are acceptable.

B. All such insulation shall be of one manufacturer.

C. Other Manufacturers: Submit Substitution Request.

2.2 PIPE INSULATION

A. Fiberglass: Split sectional or snap-on type with 0.23 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature, 850°F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system. Johns Manville Microlok HP.

B. Elastomeric: Expanded closed cell, 0.27 per inch maximum K-factor at 75°F mean temperature, 220°F maximum service rating with fitting covers and paintable surface. ArmacellAP Armaflex, Rubatex.

C. Polyolefin: Semi-rigid polyolefin form snap-on or slip over type with 0.24 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature -165°F to 210°F service factor and paintable surface. End joints in insulation on piping with fluid temperatures normally below 65°F fuse sealed in accordance with the manufacturer's instructions. Joints longitudinal joints and other end joints made with manufacturer's approval contact adhesive in accordance with the manufacturer's instructions. Joints may be pre-glued or pre-coated with adhesive where applicable.

2.3 BLOCK INSULATION

A. Fiberglass: 1-1/2-inch thick unless specified or shown otherwise with 3 pcf nominal density, 0.23 per inch maximum K-factor at 75°F mean temperature and 450°F minimum operating temperature limit. Johns Manville 1000 Series.

2.4 DUCTWORK BLANKET INSULATION

A. Fiberglass: 1.0 pcf nominal density, 0.25 per inch maximum K-factor at 75°F mean temperature, 250°F minimum operating temperature limit. Johns Manville Microlite Type 100 with facing as follows:
   1. Exposed: FSK facing (foil scrim Kraft) or vinyl - white appearance.
   2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
   3. Concealed without Vapor Barrier: Facing not required.

B. Semi-Rigid Fiberglass: 2.5 pcf nominal density, 0.24 per inch maximum K-factor, at 75°F mean temperature, 250°F minimum operating temperature limit. Johns Manville Micro-Flex with facing as follows:
   1. Exposed: FSK facing (foil scrim kraft) or vinyl-white appearance.
   2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
   3. Concealed without Vapor Barrier: Facing not required.

C. Elastomeric: Expanded closed cell sheets, 0.27 per inch maximum K-factor at 75°F mean temperature and 220°F minimum operating temperature limit. ArmacellArmaflex.

2.5 DUCTWORK BOARD INSULATION

A. Semi-Rigid Fiberglass: 0.23 per inch maximum K-factor at 75°F mean temperature, 250°F minimum operating temperature limit and all-purpose vapor barrier facing with white Kraft paper finish. Micro-Aire Duct Board Type LP.

B. Rigid Fiberglass: Same as semi-rigid except with 4.0 pcf density and 0.23 per inch maximum K-factor. Johns Manville Diffuser Board.

2.6 DUCT INSULATION, INTERNAL

A. Description: Fiberglass with airstream surface protected with a glass mat facing that contains an EPA registered anti-microbial agent proven to resist microbial growth as determined by ASTM G21 and G22, 1-inch thick unless indicated otherwise. 2-inch thick insulation shall have 0.24 per inch maximum K-Factor at 75°F mean temperature. Johns Manville Duct Liner PM for rectangular ductwork.

B. Acoustical Absorption Coefficients: With minimum NRC of 0.70 for 1-inch and 0.90 for 2-inch as tested in accordance with ASTM C-423-90, type A mounting.

C. Liner must meet ASTM C1071.

2.7 DUCT ENCLOSURE, FIRE RATED

A. Johns Manville:
   1. Material:
      a. 2-hour Rated: Johns Manville “Super Firetemp M”, minimum 3-inch thickness, ASTME2336, 2-hour rated assembly.
      b. 1-hour Rated: Johns Manville "Super Firetemp L", minimum 2-1/4-inch thickness, ASTM E2336, 1-hour rated assembly.
   2. Joint: Johns Manville “Super Calstik” adhesive, modified sodium silicate adhesive.

B. Firemaster:
   1. Material: Thermal Ceramics “Firemaster” duct wrap ceramic fiber blanket, minimum 3-inch total thickness, ASTM E2336, 2-hour rated assembly.

C. Fyrewrap:
   1. Material: Unifrax “Fyrewrap” duct wrap fiberglass blanket, 1.5-inch thickness for 1-hour rated assembly, 3-inch thickness for 2-hour rated assembly. ASTM E2336.

2.8 ACCESSORIES PIPING

A. Adhesives:
   1. Fiberglass: Zeston Z-Glu.
   2. Elastomeric: Armacell 520.
   3. Polyolefin: As approved by the insulation manufacturer.

B. Cements:
   1. Insulating: Ryder.
   2. Heat Transfer: Zeston Z-20.

C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.

E. Grooved Coupling Insulation: One piece PVC insulated fitting cover. Zeston, Ceel-Co.

F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.

G. Cloth Facing: Presized fiberglass cloth.

H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.

I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

2.9 ACCESSORIES DUCTWORK

A. Adhesives:
   1. Fiberglass: Zeston Z-Glu.
   2. Duct Insulation, Internal: Benjamin Foster 85-20.

B. Weld Pins: Duro-Dyne with NC-1 nylon stop clips.

C. Cements:
   1. Insulating: Ryder.
   2. Heat Transfer: Zeston Z-20.

D. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

E. Mastic: Chicago Mastic:
   1. Vapor Barrier: 17-475.
   2. Outdoor Mastic: 16-110 white.

F. Cloth Facing: Presized fiberglass cloth.

G. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.

H. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship:
   1. Installation: Insulation installed in first class, neat professional manner.
   2. Applicators: Applicators shall be employed by firm that specializes in insulation work.

B. Preparation: Surfaces of piping, ductwork and equipment clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels shall not be covered.

3.2 HVAC PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – HVAC Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Heating Water (to 250°F)	1 1/4-inch and smaller	Fiberglass	2-inch	Note 1
	1 1/2-inch to 6-inch	Fiberglass	2 1/2-inch	Note 1
Chilled Water	1 1/4-inch to 6-inch	Fiberglass	1 1/2-inch	Note 1
Pre-Insulated Chilled Water	All	Polyurethane foam	1 1/2-inch	Note 2
Dual Temp Water	1 ¼-inch and smaller	Fiberglass	2-inch	Note 1
	1 1/2-inch to 6-inch.	Fiberglass	2 ½-inch	Note 1
Refrigerant Suction, Hot Gas	All	Elastomeric or Polyolefin	1 1/2-inch	Note 3
Air Separators and Storage Tanks	All	Fiberglass	3 1/2-inch	
		Elastomeric or Polyolefin	3 1/2-inch	Note 3
Note 1: Cover with metal pipe jacket where exposed to weather and overheat trace cable. Note 2: Refer to specification 23 20 14 for additional pre-insulated piping systems requirements. Note 3: Elastomeric or Polyolefin insulation not allowed over heat trace cable.				

B. The following piping is not insulated:
   1. Refrigerant relief valve discharge.

C. Insulation shall include all fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves.
   1. Hot water heating inside building.

D. Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4 feet of the coils and the pipe size is 1-inch or less.

E. Valves and irregular fittings shall be insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 oz. canvas and Foster 30-36 lagging adhesive. The contractor shall have the option on all flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 oz. glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge S.S. lacing wire.

F. Expansion Joints and Flexible Connectors: Pipe insulation or block of same material and thickness as adjacent piping.

3.3 PIPING INSTALLATION

A. General:
   1. Joints: Coat both sides of complete joining area with applicable adhesive.
      a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
      b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
      c. Multiple Layered Insulation: Joints staggered.
   2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
   3. Voids: Fill all voids, chipped corners and other openings with insulating cement or material compatible with insulating material. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
   4. Seal joints, seams and fittings of metal watertight jackets at exterior locations.

B. Fiberglass Insulation: Exterior insulation encased in metal jacket.

C. Elastomeric and Polyolefin Insulation:
   1. Slit full length and snap around pipe.
   2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
   3. Do not stretch insulation to cover joints or fittings.
   4. Seal joints in elastomeric insulation with adhesive.
   5. Seal joints in polyolefin as specified hereinbefore.
   6. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
   7. Sealing joints with tape will not be allowed.

D. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
   1. On Elastomeric and Polyolefin Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
   2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

E. Unions, Mechanical Joints, Valves, Etc.:
   1. General:
      a. As specified for fittings.
      b. Minimum thickness same as specified for piping.
   2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
   3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
   4. Flanged Valves: Insulation with square corners.

F. Vapor Barrier Insulation:
   1. Refer to Section 23 05 29 for support requirements.
   2. Piping which requires vapor barrier protection shall have a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
      a. Chilled water.
      b. Refrigerant suction.
      c. All other piping systems with a nominal operating temperature below 65°F, including dual temperature piping.
   3. Vapor Barrier Insulation.
      a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
      b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 23 05 29.

G. Non-Vapor Barrier Insulation:
   1. Refer to Section 23 05 29 for support requirements.
   2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
   3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
   4. Void between saddle and pipe filled with insulation.

3.4 EQUIPMENT INSTALLATION

A. General: Install true and smooth. Insulation over curved surfaces shall conform to curves of surface.
   1. Access: Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance shall be provided with covers or section that are easily removable and replaceable. Reinforce openings in adjacent insulation with metal beading. In vapor barriered insulation, coat joints with vapor barrier mastic.
   2. Voids, Depressions and Cavities: All voids, chipped corners and other openings shall be filled with insulating cement or material compatible with insulating material.
   3. Vapor Barriered Insulation: Where insulation is specified to have a vapor barrier, the barrier shall not be pierced or broken.
      a. Tears, etc., shall be coated with vapor barrier mastic and patched with insulation facing or tape.
      b. Staples brush coated with vapor barrier coating.
      c. All raw edges coated with vapor barrier mastic shall be covered and cover shall be sealed to equipment surface.
   4. Non-Vapor Barriered Insulation:
      a. Tears, etc., shall be patched with insulation facing or tape.
      b. All raw edges shall be covered and neatly beveled to the equipment surface.
   5. Multilayered Insulation: With staggered joints.

B. Calcium Silicate and Fiberglass Block:
   1. Anchors: Lug nuts 10 gauge black annealed iron wire welded to metal surfaces.
   2. Banding: Block secured to surface with 1/2-inch wide stainless steel bands maximum 18-inches on center and secured to anchors.
   3. Insulating Cement: Block covered with insulating cement minimum thickness of 1/2-inch with smooth finish.
   4. Vapor Barriered System: On vapor barriered system, apply continuous coat of vapor barrier mastic.
   5. Finish: Finish with cloth facing secured with adhesive and lapped a minimum of 2 inches. Defects touched up with finishing cement.

C. Elastomeric Blanket: Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.

D. Expansion Joints: Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system and finished with cloth facing cemented to insulation with adhesive.

3.5 DUCT INSULATION APPLIED LOCATIONS

A. General:
1. All external insulation with continuous vapor barriers unless specifically noted otherwise.
2. Internally lined shall be lined completely to grille or diffuser or to indicated terminal points. Dimension shown are net inside of liner.
3. Internally lined ductwork need not be externally insulated.
4. In addition to locations described in specification, internally line supply, return and exhaust air ductwork where shown on drawings.

B. Insulation Applied Location – HVAC Ductwork, per table below and as follows where more stringent:
1.
2. Commons Air Handler AH-COMMONS: Line all return air duct. Line all supply air duct located in mechanical platform.
3. Gym Air Handlers: Line all return air duct. Line all supply air duct located in mechanical platform.
4. Conf Room 119: Line entire return air branch duct.
5. Conf Room 121: Line entire return air branch duct.
6. AH-PRACT: Line all supply and return duct including branches to inlets and outlets.
7. AH-BAND: Line supply ducts 15 feet both sides of east wall of room. Line return duct behind return grill and 30 feet upstream.
8. AH-CHORAL: Line supply and return duct 10 feet both sides of east wall.
9. AH-DRAMA: Line supply duct 10 feet both sides of east wall. Line return duct behind return grille and 20 feet upstream.
10. AH-ENSEMB: Line all supply and return duct except branches to Storage and Hallway.
11. TU-PRIN: Line main supply duct downstream of duct coil all the way to Room 110.
12. TU-VP: Line all supply duct downstream of duct coil.
13. TU-COUN: Line supply duct between Room 112 supply diffuser flex duct and Room 114 flex duct.
14. Remaining Terminal Units: Line a minimum of five feet downstream of duct coil

System	Location	Duct Type	Insulation Type	Thickness	Notes
Low Pressure Supply*	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	1 1/2-inch	
		Round	Internally Lined	1 1/2-inch	Note 5
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1 1/2-inch	
	15 ft downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	Note 5 Note 7
Return Air* (Not insulated except:)	Concealed Outside Building Envelope	All	Externally insulated without vapor barrier	2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	2-inch	Note 5
	15 ft upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	Note 5

System	Location	Duct Type	Insulation Type	Thickness	Notes
Exhaust Air* (Not insulated except:)	15 ft upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	Note 5
	In Toilet Rooms, 10 ft downstream of exhaust grilles	All	Internally Lined	1-inch	Note 5
Outside Air (Untempered)	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	2-inch	
		Round	Internally Lined	2-inch	Note 5
	Concealed or in mechanical rooms	All	Fiberglass Blanket	2-inch	
Supply and Return Plenums	All	All	Internally Lined	2-inch	Note 2
Grease Hood Exhaust	All	All	Duct Enclosure, Fire Rated	As Indicated	
Transfer Air	All	All	Internally Lined	1-inch	Note 5
OSA and Relief Plenums at Louvers	All	All	Fiberglass Blanket or Board	R-20 Equiv	Note 6

* In addition to applied locations listed in this table, provide internally lined ductwork where indicated on drawings.
Note 2: Insulation not required on factory fabricated insulated housings and plenums (AHP).
Note 3: Where round or oval ductwork is indicated, provide double walled as specified in 23 31 02.
Note 4: Use semi-rigid blanket for galvanized sheet metal duct and use semi-rigid board for stainless steel duct.
Note 5: Where round or oval ductwork is indicated, provide double walled round/oval ductwork as specified in 23 31 02, or provide internally lined rectangular ductwork with equivalent free area.
Note 6: Plenums at louvers shall be insulated where extending beyond control damper.
Note 7: Where liner is used to meet Energy Code, thickness shall be 1-1/2-inches.

3.6 DUCTWORK INSTALLATION

A. General:
   1. Install in accordance with manufacturer's instruction.
   2. The vapor barrier shall be continuous. Tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape. Joints between insulation and access with vapor barrier mastic.
   3. Insulation at access panels to be removable or attached to panel with edges of panel and opening reinforced with metal beading.

B. External Blanket Insulation:
   1. Insulation secured to ductwork with 20-gauge snap wires 24 inches on center and at all joints.
   2. Joints and seams lapped a minimum of 3 inches and sealed with jacket tape.

C. Board Insulation:
   1. Rectangular ducts with weld pins spaced a maximum of 18 inches on center in both directions.
   2. All corners made with joints, bending insulation around corners not allowed.

3. All joints and seams butted tight together.
4. Butt joints with 3-inch wide tape.
5. Corners finished with 3-inch wide tape.

D. Internal Duct Liner:
1. The coated surface shall face air stream.
2. Weld pins spaced maximum of 15-inch on center in both directions and within 2 inches of all corners and joints. Weld pins flush with liner surface.
3. Complete duct surface coated with adhesive and insulation pressed tightly thereto.
4. Edges at terminal points shall be provided with metal beading and heavily coated with adhesive.
5. All joints and corners shall be heavily coated with adhesive.
6. Damaged areas replaced or heavily coated with adhesive.

E. Duct Enclosure - Fire Rated:
1. Installation: Per manufacturer's instructions.
2. Joints:
   a. Attached boards shall be cemented and attached to one another. Mating surfaces shall be "buttered" with a 1/8-inch layer adhesive.
   b. Secure fiberglass type material with stainless steel banding (type 304).
3. Support: The duct enclosure may be hung from a conventional "trapeze" arrangement. Adequate support shall be provided at the bottom of vertical runs. On multi-story vertical runs, the Firetemp enclosure shall be supported at each story penetration with an angle iron collar attached to the Firetemp.
4. Expansion: Adequate clearance shall be provided at the end of all straight runs to allow for expansion of the metal duct inside the enclosure.

F. Plenums: Insulation on floors protected by wire mesh.

G. Blank Off Panels: Insulation, enclosed with sheet metal on all sides. All joints with vapor barrier mastic and taped.

H. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep and finish edges to maintain vapor barrier and to prevent damage to the insulation.

3.7 DUCT, PIPE AND TERMINAL UNIT ACOUSTICAL WRAP

A. Installed in accordance with the manufacturer's instructions.

B. Applied locations for piping and duct systems:
1. Where specified or indicated on drawings.

3.8 DUCT ENCLOSURE - FIRE RATED:
1. Installation: Per manufacturer's instructions.
2. Joints:
   a. Attached boards shall be cemented and attached to one another. Mating surfaces shall be "buttered" with a 1/8-inch layer adhesive.
   b. Secure fiberglass type material with stainless steel banding (type 304).
3. Support: The duct enclosure may be hung from a conventional "trapeze" arrangement. Adequate support shall be provided at the bottom of vertical runs. On multi-story vertical runs, the Firetemp enclosure shall be supported at each story penetration with an angle iron collar attached to the Firetemp.
4. Expansion: Adequate clearance shall be provided at the end of all straight runs to allow for expansion of the metal duct inside the enclosure.
5. Provide continuous duct enclosure from point of ceiling penetration to termination per OMSC 506.3.10.2.

3.9 FIELD QUALITY CONTROL

A. Field Test: All systems shall be tested and approved prior to installation of insulation.

END OF SECTION

COMMISSIONING FOR HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

C. The Work of this Section is supplemental to and does not supersede any other requirements of the Contract Documents.

1.2 SUMMARY

A. The commissioning process is described in Section 01 91 13 General Commissioning Requirements.

B. Provide all labor and materials required to complete the commissioning of those Division 23 systems and equipment identified as Commissioned Systems and Equipment in Section 01 91 13.

C. Related Sections include:
   1. Section 01 91 13 General Commissioning Requirements.
   2. All Sections of Division 23.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.4 COMMISSIONING SCOPE OF WORK - COMMISSIONING AGENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.5 COMMISSIONING SCOPE OF WORK - CONTRACTOR

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 3 - EXECUTION

3.1 MEETINGS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.2 INSTALLATION, CHECK-OUT, START-UP AND PREFUNCTIONAL CHECKS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.3 FUNCTIONAL TESTING

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.4 TRAINING OF FACILITY OPERATING STAFF AND BUILDING OCCUPANTS

A. Refer to Section 01 91 13 General Commissioning Requirements.

END OF SECTION

PREFABRICATED PIPING SYSTEMS FOR HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Direct buried prefabricated piping systems for chilled water.

B. Related Sections include:
   1. Section 23 05 90 Pressure Testing for HVAC Systems.
   2. Section 23 07 00 Insulation for HVAC.
   3. Section 23 21 13 Pipe and Pipe Fittings HVAC.

1.3 SUBMITTALS

A. Submit the following:
   1. Product Data.
   2. Installation Manuals.
   3. Complete shop drawings for piping systems including elbows, tees, flanges, coupling locations, and anchors. Include cutting lengths and thrust block sizes.
   4. Report on field piping tests with signatures of Architect and manufacturer's representative witnessing.

1.4 QUALITY ASSURANCE

A. Provide the services of a qualified manufacturer's representative to instruct the contractor on the installation procedures for piping, and to be present on site to assist during critical stages of installation and testing.

B. Include a report consisting of the installation log indicating actual installed conditions and test certification signed by the manufacturer's representative above, the contractor, and the Architect's representative. Include certification by manufacturer's representative that the installation is in conformance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 PREFABRICATED PEX OR HDPE CHILLED WATER PIPING

A. Acceptable Manufacturers:
   1. Rovanco, Thermacore, Perma-Pipe, Thermal Pipe, and Insul-pipe.
   2. Other Manufacturers: Submit Substitution Request.

B. General: Provide complete prefabricated underground chilled water piping system suitable for direct burial as indicated on Drawings and as specified herein. Factory prefabricated HDPE jacketed system of factory pre-insulated pipe with all necessary fittings, seals, and accessories.

C. Pipe: Carrier pipe shall be Cross-linked PEX pipe 100 psi minimum working pressure for temperatures up to 180ºF and or High Density Polyethylene pipe DR-17, 100 psiminimum working pressure for temperatures up to 110ºF.

D. Expansion: All components of carrier pipe, insulation, and jacket must be able to expand and contract as a unit without overstressing or adversely affecting any of the materials. The piping system supplier shall be responsible for the overall design of the expansion and contraction compensation.

E. End Seals: All direct-buried ends of insulated pipe with exposed insulation will be sealed with polyethylene end seals.

F. Insulation: Insulation shall be as specified in Section 23 07 00 Insulation for HVAC.

G. Jacket: The outer protective jacket shall be corrugated seamless polyethylene completely encompassing and protecting the insulation from moisture and damage, designed for H-20 loading at a burial depth of 2-ft minimum.

H. Joints: Straight run joints shall be field-insulated per the manufacturer's instructions, using polyurethane foam poured in an HDPE sleeve and sealed with a heat shrink sleeve. All joint closures and insulation shall occur at straight sections of pipe. All insulation and jacketing materials shall be furnished by piping system supplier.

I. Fittings: Fittings shall be standard component factory prefabricated and pre-insulated to the thickness specified.

J. Accessories: Provide all required accessories including wall sleeves, and miscellaneous materials as required for attachment to steel or copper pipe at ends and as required and detailed to a complete and total installation.

K. Service:
   1. Chilled Water.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measurements, Lines and Levels:
   1. Check dimension at the building site and establish lines and levels for the work specified in this Section.
   2. Establish all inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
   3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.2 EXCAVATION AND BACKFILL

A. General: Perform all necessary excavation and backfill required for the installation of mechanical work in accord with Division 2. Repair pipelines or other work damaged during excavation and backfilling.

B. Excavation: Excavate trenches to the necessary depth and width, removing rocks, roots, and stumps. Include additional excavation to facilitate utility crossovers, additional offsets, etc. Excavation material is unclassified. Width of trench shall be adequate for proper installation of piping. The trench shall be widened if not wide enough for a proper installation.

C. Bedding: All piping shall be full bedded on sand. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose.

D. Backfill:
   1. Immediately after all piping is installed in the ditch, make a partial backfill in the middle of each pipe length leaving the joints exposed for inspection prior to the hydrostatic tests.
   2. Place in layers not exceeding 8 inches deep and compact to 95% of standard proctor maximum density at optimum moisture content. Earth backfill shall be free of rocks over 2 inches in diameter and foreign matter. Disposal of excess material as directed.
   3. Interior: All backfill under interior slabs shall be bank sand or pea gravel.
   4. Exterior: Excavated material may be used outside of buildings at the contractor's option. The first 4 inches shall be sand, and final 12-inch layer course shall be soil in any event.

3.3 ADJUSTING AND CLEANING

A. General:
   1. Clean interior of all piping before installation.
   2. Flush sediment out of all installed piping systems.

3.4 INSTALLATION OF PEX AND HDPE CHILLED WATER PIPING

A. Install piping in accordance with the Manufacturer's recommendations and installation Drawings.

B. Install all piping as to vent and drain to building.

C. The system shall be installed in a manner that will not require expansion loops or compensators of any type.

D. The system shall be installed with the fewest number of underground joints possible.

E. Make connection between PEX or HDPE and Copper or Steel pipe according to manufacturer's recommendations.

F. Slope piping uniformly. Record exact location and depth with respect to established datum points.

G. Test piping prior to sealing of conduits and before backfilling. Seal all leaks and retest until tight.

H. Utility Marking: Installed over the entire length of the underground piping utilities. Install plastic tape along both sides and the center line of the trenches at the elevation of approximately 12 inches above the top of utility.

I. Trace Wire: Install 16 gauge insulated copper tracer wire (green in color) above all buried nonmetallic piping. Tracer wire to run entire length of pipe.

END OF SECTION

PIPE AND PIPE FITTINGS HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Furnish piping, pipe fittings, and incidental related items as required for complete piping systems, and treatment of HVAC water systems.

B. Related Sections Include:
   1. Section 23 25 00 HVAC Water Treatment.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Piping material and installation to meet requirements of the local building codes and serving utility requirements.

B. All grooved joint couplings and fittings shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

C. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, re-clean, and reconnect without additional expense to the Owner.

D. Correct any damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.4 SUBMITTALS

A. Submit the Following:
   1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).
   2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.
   3. Certificate of completion
   4. Treatment Reports

B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

C. Other: Make certified welders' certificates available.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As indicated.

2.2 BLACK STEEL PIPE, SCHEDULE 40 AND STANDARD

A. Pipe: Schedule 40 conforming to ASTM A 135 or A 53. Schedule 40 up to 10-inch diameter. Standard weight for 12-inch diameter and above.

B. Fittings: 150 lb. screwed malleable iron on 2 inches and below, Schedule 40 welding fittings conforming to ASTM A 234 for 2-1/2 inches and above or mechanical couplings on select piping as herein specified. Fittings below grade shall be welding fittings. All elbows on pumped systems shall be long radius type. Short radius elbows not acceptable for use except as approved on a case by case basis.

C. Service:
   1. Chilled and heating water piping up to and including 6-inches.
   2. Safety and relief valve discharge.

2.3 COPPER PIPE

A. Pipe: Hard drawn copper tubing, Class L, ASTM B 88.

B. Fittings:
   1. Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal.

C. Service:
   1. Refrigerant piping (Type L, hard drawn, ACR cleaned).
   2. Chilled and heating water piping (Type L, hard drawn) up to and including 4-inches.

2.4 PVC PIPE

A. Pipe: Schedule 80 PVC, normal impact, Type 1, ASTM D 1785.

B. Fittings: Schedule 80 PVC, deep socket, solvent welded, ASTM D2467.

C. Service:
   1. Coil condensate drains and traps, boiler condensate drains, and other miscellaneous drains.
   2. Except not allowed in return air plenums.

2.5 FLANGED JOINTS

A. Flanged Joints: Flanges shall be cast iron or steel for screwed piping and forged steel welding neck for welded line sizes. Pressure rating and drilling shall match the apparatus, valve, or fitting to which they are attached. Flanges shall be in accordance with ANSI B16.1; 150 lb. for system pressures to 150 psig; 300 lb. for system pressures 150 psig to 400 psig. Gaskets for all flanged services, except steam and pumped condensate, shall be Garlock 3700 or equal, 1/8-inch thick, non-metallic type. Gaskets for steam and pumped condensate shall be Flexitaulic Style CG or equal, 1/8-inch thick, semi-metallic type. Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nuts (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig. Use length of bolt required for full nut engagement. Provide electro-cad plated bolts and nuts on cold and chilled water lines.

2.6 UNIONS

A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.

B. Dielectric fittings shall be nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F-492. Fittings shall be suitable for the pressure and temperature to be encountered.

2.7 SOLDERING AND BRAZING

A. Brazed Joints:
   1. Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.

2. Applied locations:
   a. All below grade piping.
   b. All above grade piping larger than 2-inches for the following services: heating water, chilled water.
   c. Refrigerant piping. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.

B. Soldered Joints:
1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
3. Applied locations: Above grade piping 2-inch and smaller for the following services: Heating water, chilled water.,

C. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.

2.8 RADIANT FLOOR HEATING PIPING

A. Approved Manufacturer: Zurn, Wirsbo, Rehau, Heat Link, or equal.

B. Description:
1. Tubing cross-linked polyethylene oxygen diffusion barrier tubing rated at 180°F maximum working temperature and 100 psi working pressure. Oxygen barrier shall conform to DIN 4726. The tubing shall be manufactured in accordance with ASTM F876 using the Engel method (PEX-A).
2. Fittings shall be manufactured of dezincification resistant brass with barbed insert, compression ring, and compression nut and shall be compatible with the tubing and shall not permit excessive oxygen permeation.

C. Service: Slab Heating.

2.9 POLYPROPYLENE PIPING

A. Approved Manufacturer: Aquatherm Blue Pipe MF.

B. Description: Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. Hydronic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

C. Fittings: Same material as piping.

D. Service: Chilled and heating water piping up to and including 6-inches.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measurements, Lines and Levels:
1. Check dimension at the building site and establish lines and levels for work specified in this Section.
2. Establish all inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.2 PIPING INSTALLATION

A. Install unions in all non-flanged piping connections to apparatus and adjacent to all screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.

B. Install all piping as to vent and drain. Install according to manufacturer's recommendations.

C. Support all piping independently at apparatus so that its weight shall not be carried by the equipment.

D. Run piping clear of tube cleaning or removal/replacement access area on coils, heat exchangers, chillers, etc.

E. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.

3.3 PIPING JOINTS

A. Pipe and fittings shall be joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. shall be done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.

B. Purge refrigerant piping with nitrogen continuously during the piping installation, and seal each branch outlet with Visqueen and tape or similar method to assure continued cleanliness of interior of piping until system is completed.

C. Copper Piping: Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished. Joint shall be uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.

D. No couplings installed in floor or wall sleeves.

E. Steel Piping:
   1. Screwed Joints: Pipes cut evenly with pipe cutter reamed to full inside diameter with all burrs and cuttings removed. Joints made up with suitable lubricant or Teflon tape applied to male threads only, leaving two threads bare. Joints tightened so that not more than two threads are left showing. Junctions between galvanized steel waste pipe and bell of cast iron pipe shall be made with tapped spigot or half coupling on steel pipe to form spigot end and caulked.
   2. Flanged Joints: Pressure rating of flanges shall match valve or fitting joined. Joint gaskets shall be coated with graphite and oil.

F. Welded Joints:
   1. Preparation for Welding: Bevel piping on both ends before welding:
      a. Use following weld spacing on all buttwelds:

Nominal Pipe Wall Thickness	Spacing	Bevel
1/4-inch or less	1/8-inch	37-1/2
Over 1/4-inch, less than 3/4-inch	3/16-inch	27-1/2

      b. Before welding, remove all corrosion products and foreign material from surfaces.
   2. Welded Joints: Joints shall be made by the "arc-welding" process using certified welders. Port openings of fittings must match the inside diameter of the pipe to which they are welded. Use full radius welding elbows for all turns, use welding tees for all tees. Reducing fittings must be used for size reduction. "Weldolets" may be used for branches up through one-half the pipe size of the main to which they are attached. Nipples are not allowed.

3. Welding Operation:
    a. After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.
    b. Weld reinforcement no less than 1/16-inch not more than 1/8-inch above normal surface of jointed sections. Reinforcement crowned at center and taper on each side to surfaces being joined. Exposed surface of weld shall present professional appearance and be free of depressions below surface of jointed members.
    c. No welding shall be done when temperature of base metal is lower than 0°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Metal shall be “warm to the hand” or approximately 60°F.

G. Screwed Joints: Use Teflon tape or Teflon liquid dope applied to male threads only.

H. Flexible Couplings: Provide where indicated on the Drawings.

I. PVC Piping: Socket weld joints with solvent cement and application method recommended by manufacturer. Use power saw and miter box to cut PVC pipe, except DI piping must be cut with a wheel cutter specifically made for plastics. Allow proper curing time based on temperature range during cure period before pressure testing.

J. Polypropylene joints: Fusion welding per manufacturer’s requirements.

3.4 ADJUSTING AND CLEANING

A. General:
1. Clean interior of all piping before installation.
2. Flush sediment out of all piping systems after installation before connecting mechanical equipment to the piping.
3. When placing the water systems in service during construction, each system shall be cleaned by circulating a solution with 1000 ppm of trisodium phosphate for 24 hours, then drained, flushed and placed in service.
4. Clean all strainers prior to placing in service.

3.5 INSTALLATION, RADIANT FLOOR HEATING SYSTEM PIPING

A. Install piping per manufacturer’s recommendations.

END OF SECTION

PUMPS FOR HVAC

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Base Mounted Centrifugal Pumps
   2. In-Line Circulating Pumps
   3. Condensate Pumps

1.3 QUALITY ASSURANCE

A. Select pump impellers such that impellers shall not be greater than minimum impeller size plus 90 percent of the difference between the maximum and minimum impeller size for pump selected.

B. Select motor to be non-overloading under all operating conditions.

C. Select pump with a minimum efficiency as listed in schedule.

D. Provide couplings and seals suitable for application (including temperature, pH, glycol solution concentration, and loads over full range of pump operation).

E. Pumps and motors with flexible couplers shall be factory aligned, and shall be realigned by manufacturer's representative after installation.

1.4 SUBMITTALS

A. Submit the following:
   1. Product data for each pump including performance curves, pump efficiency, motor data, operating weights, and pressure ratings. Submit control information and wiring diagrams for packaged equipment.
   2. Operating and maintenance data for each product specified under this Section.

PART 2 - PRODUCTS

2.1 BASE MOUNTED CENTRIFUGAL PUMPS

A. Acceptable Manufacturers:
   1. Paco, Peerless, Bell and Gossett, Goulds, Armstrong, Taco, Thrush, Aurora.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: End suction centrifugal pump, motor, flexible coupling drive mounted on a common steel baseplate.

C. Components:
   1. Vertical split case construction, cast iron volute, bronze fitted.
   2. 175 psig working pressure unless otherwise noted.
   3. Enclosed type, single stage, bronze impeller.
   4. Mechanical shaft seal, regreasable ball bearings.
   5. Motor: 1750 RPM maximum speed.
   6. Coupling drive and guard.
   7. Steel baseplate with open grouting area.

8. Pump internals capable of being serviced without disturbing piping.
9. Capacity head and power requirements as scheduled on Drawings.

2.2 IN-LINE CIRCULATING PUMPS

A. Acceptable Manufacturers:
   1. Bell and Gossett, Armstrong, Paco, Peerless, Grundfos, Aurora.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Pipe mounted, integral centrifugal pump and resiliently mounted motor.
   2. Rigid coupling between pump and motor.
   3. Mechanical shaft seals.
   4. Bronze fitted construction.
   5. Motor: 1750 RPM or 3500 RPM maximum speed as scheduled.

2.3 CONDENSATE PUMPS

A. Acceptable Manufacturers:
   1. Little Giant.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Pump for removal of evaporator condensate, complete with integral float switch, receiver, power cord, safety switch, and check valve. Factory piped, wired, assembled and tested. Capacity, head and power requirements as required.

C. Components:
   1. Integral float switch
   2. Receiver
   3. Power cord
   4. Safety switch
   5. Discharge check valve.

PART 3 - EXECUTION

3.1 BASE MOUNTED CENTRIFUGAL PUMP INSTALLATION

A. Install pump in location shown in accordance with manufacturer’s written installation instructions.

B. Install on inertia base.

C. Provide flexible connections, strainers, check valves and shutoff valves on suction and discharge as shown on Drawings.

D. Lubricate in accordance with manufacturer’s instructions before operation.

E. Support interconnecting piping independently of pump and inertia base to prevent stresses from being transmitted to the casings.

3.2 IN-LINE CIRCULATING PUMP INSTALLATION

A. Install pump in accordance with manufacturer’s written installation instructions.

B. Provide for convenient access to oil cups and as required by the manufacturer.

C. Provide flexible connections, strainers, check valves and shutoff valves on suction and discharge as shown on Drawings.

D. Lubricate in accordance with manufacturer’s instructions before operation.

E. Support and isolate circulators as specified and as scheduled on the Drawings.

3.3 CONDENSATE PUMP INSTALLATION

A. Provide where evaporator condensate cannot drain by gravity to available points of discharge.

B. Select pump with adequate head capacity.

C. Coordinate location of power outlet with Div. 26.

END OF SECTION

HVAC WATER TREATMENT

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Treatment HVAC water systems.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop drawings.
   2. Product data.
   3. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE CHEMICAL TREATMENT MANUFACTURER/SUPPLIER

A. ChemAqua (Tom Hubbard, 541-505-1768).

2.2 HVAC WATER TREATMENT

A. Closed Loop Systems Chemicals: Will be provided by School District's chemical treatment provider.
   1. One Shot Feeder:
      a. Description: Furnished and install one-shot chemical bypass feeders on each closed loop system where water treatment is specified.
      b. Construction: Each feeder shall be 2 quart, 4 quart, 10 quart or maximum of 5 gallon volume as required to initially treat the system served in two shots. Pressure rating shall be 150 psig or 300 psig to match other valve and pressure vessel ratings. Provide fill funnel and valve, air vent cock and drain valve and plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. HVAC Closed Loop Systems:
   1. Install shot feeders across pump or appropriate restricting valve with adequate mounting to prevent piping damage and preclude transmitting vibration to structure.
   2. Filling may be through bypass shot feeder across pump.
   3. Final system treatment shall achieve 800-1200ppm Sodium Nitrite in the system water. Tolyltriazole levels of minimum 3ppm in all closed loop water shall be applied.
   4. Test to confirm proper inhibitor levels.

3.2 FINAL ADJUSTMENT

A. When the systems are accepted by the Owner the chemical treatment supplier shall make final adjustments in the required concentrations.

END OF SECTION

HVAC DUCTS AND CASING-LOW PRESSURE

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Low pressure ductwork and fittings.

B. Related Sections include:
   1. Section 23 05 48 Vibration and Seismic Controls for HVAC Piping Equipment.
   2. Section 23 07 00 Insulation for HVAC.
   3. Section 23 33 00 Air Duct Accessories.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.

B. Regulatory Requirements:
   1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
   2. Ductwork and components shall be listed as U.L. 181, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.4 SUBMITTALS

A. Submit the following:
   1. Provide catalog data on each product specified hereunder.
   2. Schedule of duct construction standards.
   3. Provide shop drawings showing materials and construction details for single wall housing plenum.
   4. Provide shop drawings showing construction details, support and seismic restraint of ductwork distribution systems.

PART 2 - PRODUCTS

2.1 SUPPORTS, ANCHORAGE AND RESTRAINTS

A. General:
   1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
   2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
   3. Seismic restraints shall follow the provisions described in Section 23 05 48, Vibration and Seismic Control for HVAC Piping and Equipment.
   4. Seismic restraints shall not introduce stresses in the ductwork caused by thermal expansion or contraction.
   5. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Suspended Ductwork: Seismic restraints shall be in accordance with the latest edition of the SMACNA “Seismic Restraint Manual - Guidelines for Mechanical Systems” for the seismic hazard level corresponding to the seismic zone in which the project is constructed.

C. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction:
   1. Supports and seismic restraints for suspended ductwork and equipment.
   2. Support frames for ductwork and equipment which provide support from below.
   3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.2 SHEETMETAL DUCTWORK

A. Fabricate from galvanized steel, unless noted otherwise.

B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers and supports shall be in accordance with SMACNA “HVAC Duct Construction Standards – Metal and Flexible”, Latest Edition.

C. Duct Classification: Ducts shall be considered low pressure when design velocities are 2000 fpm or less and maximum static pressure is 2 inches W.G. positive or negative.
   1. The following ductwork shall be constructed in accordance with minimum reinforcement requirements for static pressure class of 1/2-inch W.G. positive or negative.
      a. Supply ductwork downstream from terminal units.
      b. Supply, return or exhaust ductwork serving fans scheduled to operate at less than 1/2-inch W.G.
      c. Supply, return, or exhaust branch ductwork which serves one or two inlets/outlets.
   2. The following ductwork shall be constructed in accordance with minimum reinforcement requirements for static pressure class of 1-inch W.G. positive or negative.
      a. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 1 inch W.G. On supply fans pressure drops for louvers, coils, clean filters, and sound traps may be deleted from scheduled fan static.
      b. Supply, return, or exhaust ductwork serving multiple duct branches where contractor can demonstrate that pressures will not exceed 1 inch W.G. positive or negative.
      c. Boiler direct vent combustion air intake ductwork.
      d. Water heater direct vent combustion air intake ductwork.
   3. The following ductwork shall be constructed in accordance with minimum reinforcement requirements for static pressure class of 2 inches W.G., positive or negative.
      a. Supply, return, or exhaust ductwork serving fans scheduled to operate at pressures greater than 1 inch W.G. positive or negative.

D. Longitudinal seams on rectangular duct shall be Pittsburgh or Button punch snap lock. Snap lock seams for round duct may be used only on ducts classified for 1/2 inch W.G. Longitudinal seams for round ducts using lap and rivet, spot weld, or fillet weld may be used only on ducts classified for statics 1 inch W.G. or less.

E. Joining and reinforcing systems manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA “J”, and Ductmate 25 is equivalent to SMACNA “F”.

F. Use of adjustable round elbows not permitted.

2.3 SINGLE WALL HOUSING PLENUMS

A. Fabricate from galvanized steel, unless otherwise noted.

B. Minimum gauge not less than 18 gauge except panels 10'-1" or longer 16 gauge.

C. Housing panels constructed in accordance with the latest edition of SMACNA “HVAC Duct Construction Standards – Metal and Flexible”.

D. Minimum pressure classification for single wall housing panels is 2 inches W.G. positive or negative.

E. Maximum allowable panel width 24 inches with standing interlocking seams.

F. Openings in panels for air inlets/outlets, or access doors reinforced per SMACNA standards.

G. Provide intermediate reinforcing and/or bracing when spans are 8 feet or longer.

H. Line all interior surfaces of single wall plenums with minimum of 2-inch thick acoustical lining.

I. Access Doors: Construct of 20-gauge galvanized steel, double wall construction. Install in opening in plenum panel reinforced with 10-gauge channel. Doors mounted on three hinges and shall seat against neoprene gaskets. Doors in plenums at humidifiers shall have 12-inch x 12-inch double glass inserts from observation. Doors 24-inch x 60-inch height unless otherwise indicated.

2.4 FLEXIBLE DUCTS

A. Acceptable Manufacturers:
   1. Thermaflex M-KE, Gen Flex IMP-25S.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Flexible air duct with CPE or metal film liner permanently bonded to coated spring steel wire helix with 1-inch thick fiberglass insulation blanket covered with fiberglass reinforced metal film vapor barrier jacket. Duct rated for 6-inch W.G. positive and 1-inch W.G. negative.

2.5 DUCTWORK, GREASE HOOD EXHAUST

A. Materials: Stainless steel, minimum 18 gauge.

B. Fabrication: Make all joints and seams with a continuous grease tight weld on the external surface of the duct system.

C. Fittings: Elbows shall be the radius type with centerline radius equal to or greater than 1-1/2 times the depth of the duct in the plan of the turn.

D. Construct and install ductwork so that grease cannot accumulate.

E. Access Doors: 16 gauge minimum steel with gaskets and latches easily operable without the use of a tool.

2.6 EXPOSED OR VISIBLE DUCTWORK IN FINISHED SPACES

A. Round:
   1. Material: Round or flat oval, machine formed, spiral lock-seam galvanized sheet metal ductwork of thicknesses as listed for sheet metal duct. Paintable surface.
   2. Fittings: Machine formed, shop fabricated, with welded seams, designed for easiest air flow, similar to United Sheetmetal numbers listed.
      a. Mitered Elbow with Turning Vanes: Type EV-90-2.
      b. Radius Elbows: Type E090-5. Similar for less than 90 degree elbows.
      c. Tees: Type Con-T-1.
      d. Reducing Fittings: May be used unless noted otherwise.

B. Rectangular: Same as for sheet metal ductwork but paintable surface. All reinforcing shall be inside. Use special care to prevent imperfections in the metal surface.

2.7 STAINLESS STEEL DUCTWORK

A. Ductwork listed below and ductwork indicated on drawings constructed of 18 gauge minimum stainless steel with 2D finish concealed and No. 4 finish exposed. Type 304 or 316 as indicated.

B. All seams welded and liquid tight.

C. All accessories stainless steel including dampers, damper hardware, and turning vanes.

2.8 ALUMINUM DUCTWORK

A. Ductwork listed below and ductwork indicated on drawings shall be constructed of 3003-H-14 alloy aluminum. Gauge of metal and construction details to be determined by using minimum equivalent thickness and reinforcing for galvanized steel tables in SMACNA.

B. Longitudinal seams shall be Pittsburgh type. Button punch snap lock seams not allowed.

PART 3 - EXECUTION

3.1 APPLIED LOCATIONS

A. Supply ductwork on downstream side of terminal box: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00.

B. Supply Ductwork from Spin-In Fittings to Supply Outlet Collar Connection: Flexible duct, maximum 4'-0" length.

C. Return Air Trunk Ductwork from End Run to Unit Connection: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00.

D. Exhaust Ductwork: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00.

E. Ductwork between Transfer Grilles: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00.

F. Exposed or Visible Ductwork in Finished Spaces: Sheet metal as specified for application, lined where indicated on the Drawings or as specified in Section 23 07 00.

G. Stainless steel ducts:
   1. Type 304:
      a. Kitchen dishwasher and grease exhaust.

H. Aluminum ducts:
   1. Shower and moisture laden air exhaust branch ducts up to the point of connection to the main exhaust system.

3.2 INSTALLATION

A. Ductwork:
   1. Seal traverse joints with an approved mastic during joining procedure or tape after joining to provide airtight duct system.
   2. Low pressure ductwork hanger and support systems in accordance with SMACNA “HVAC Duct Construction Standards – Metal and Flexible”. Wire supports are not allowed.
   3. Provide supplementary steel for support of ductwork in shafts and between building structural members.
   4. Fabricate changes in direction to permit easy air flow, using full 1.5D radius bends or fixed turning vanes in square elbows. Radius elbows less than 1.5D radius shall have splitter vanes.
   5. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.
   6. Where pipe, structural member, or other obstruction passes through a duct, provide streamlined sheet metal collar around member and increase duct size to maintain net free area. Fit collar and caulk to make air tight.

B. Sound Attenuation (Internal Insulation):
   1. Provide sound attenuation duct where shown and as specified under Section 23 07 00.
   2. Duct dimensions shown are net inside attenuating material.

C. Dampers: Install where shown and where necessary to complete final balancing of system. Install regulators as specified in Section 23 33 00 for each specific project condition. Leave all dampers locked wide open in preparation for balancing.

D. Flexible Connectors: Make connections to fans and other rotating equipment with flexible connectors with 2-inch minimum clearance between casing and ductwork. Not required on internally spring isolated units.

E. Flexible Ducts:
1. Make connections at ends using draw band strap and a minimum of 2 wraps of duct tape.
2. Suspend center spans from structure above using wire as required by code. Connect to manufacturer's eyelet on jacket or use 1-inch wide galvanized steel strap with single loop at top and smooth edges.
3. Suspending duct by laying it on the ceiling is prohibited.
4. Avoid crimping flex duct. All changes in direction shall be made using 2D radius. Duct connections to grilles, registers and diffusers using less than 2D radius bends are not acceptable. Where space is constricted, use sheet metal elbows or Thermaflex Flex Boots (or equal).

F. Ductwork, Grease Hood Exhaust:
1. Slope minimum of 1/4 inch per foot of run toward the hood. Where horizontal ducts exceed 75 feet in length, slope minimum of 1 inch per foot of run.
2. Install access doors at every change in direction and maximum of 10 feet on center.
3. Provide access doors and allow penetrations for sprinklers as required by Fire Protection section of these specifications.
4. Install ductwork in a rated shaft as specified under other divisions of work.

G. Ductwork, Exposed or Visible in Finished Areas:
1. Use extreme care in handling and installing.
2. Replace all dented or damaged sections.
3. Install ductwork straight and true, parallel to building lines.
4. Make all connections with pop rivets using couplings where applicable. Grind all raw edges smooth and apply paintable sealant to cover imperfections.
5. Remove all excess sealant to provide a finished joint.
6. Provide floor, wall, and ceiling plates as specified in Section 23 05 00.
7. Finish, clean and prime all ductwork and hangers for painting.

H. Single Wall Housing Plenums:
1. Install housing plenums in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, latest edition.
2. All joints and seams sealed with high pressure duct sealer or gaskets and fastened with bolts, screws, or pop rivets.
3. Pipe, duct, conduit, and control penetrations sealed to prevent air leakage using close off sheets and strips.
4. Securely anchor housing panels to floor or roof curbs.
5. Block outside air or return air dampers open to prevent damage during construction until automatic control system is operational and adjusted.
6. Provide access doors where indicated on drawings and where required to provide access for cleaning and maintenance. Access doors installed to open against air pressure.
7. Slope plenum and connected ductwork to drain towards the exterior louver or building exterior opening.
8. For single wall plenums installed behind exterior louvers or wall openings, slope plenum floor and connected ductwork at 1/4-in/ft to drain towards the exterior louver or opening.
9. For single wall plenums installed below roof ventilators or roof openings, slope floor of plenum at 1/4-in/ft to drain connection. Pipe drain connection to floor drain.

I. Stainless Steel Duct: Install stainless steel ductwork similar to galvanized ductwork per SMACNA standards.

J. Aluminum Duct:
   1. Slope minimum of 1/4 inch per foot of run toward the grille.
   2. Install similar to galvanized duct work per SMACNA standards.
   3. Provide dielectric protection when joining aluminum duct to steel duct by utilizing neoprene flexible connections or other approved method.
   4. Use aluminum straps and hangers to support aluminum ductwork.

3.3 FIELD QUALITY CONTROL

A. Coordination with Balance Agency:
   1. Provide services of a sheet metal person familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating all sheet metal dampers.
   2. Install missing dampers required to complete final balancing.

END OF SECTION

AIR DUCT ACCESSORIES

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Low pressure duct accessories, sealants and tapes, flexible connectors, fire dampers, combination smoke and fire dampers, access doors, spin-in, extractors, automatic dampers, drain pans, back draft dampers.

B. Related Sections include:
   1. Section 23 31 01 HVAC Ducts and Casing-Low Pressure.
   2. Section 23 09 00 Instrumentation and Controls for HVAC.

1.3 QUALITY ASSURANCE

A. Work performed by qualified, experienced mechanics in accordance with the manual of Duct and Sheet Metal Construction of the National Association of Sheet Metal and Air Conditioning Contractors and these Specifications.

B. Install entire ductwork system, including materials and installation, in accordance with NFPA 90A.

C. Flexible connectors, flexible equipment connections, tapes and sealants listed as UL 181, Class I air duct. Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.

1.4 SUBMITTALS

A. Submit the following: Product data for Duct Accessories.
   1. Low Pressure Duct Accessories:
      a. Access Doors
      b. Backdraft Dampers
      c. Roof Jack
      d. Automatic Dampers
      e. Duct Sealer
   2. Fire and Smoke Dampers:
      a. Fire Dampers
      b. Combination Smoke and Fire Dampers

B. Operation and Maintenance Data: Automatic dampers, fire dampers. Combination smoke and fire dampers.

PART 2 - PRODUCTS

2.1 LOW PRESSURE DUCT ACCESSORIES

A. Acceptable Manufacturers:
   1. As indicated.
   2. Other Manufacturers: Submit Substitution Request.

B. Damper Regulators:
   1. Ventlok model numbers used, similar products by Young, Durodyne or approved equal are acceptable.
   2. Dial Regulator: Concealed or exposed duct in unfinished spaces, blade lengths 18-inch and less, 3/8-inch, Ventlok 635 or 638 for insulated duct. For blade lengths, 19 inches and above, similar except 1/2-inch shafts.
   3. Dial Regulator: Exposed duct finished space, 3/8-inch, Ventlok 640.
   4. Dial Regulator: Concealed, not accessible, blade lengths 18-inch and less, 3/8-inch Ventlok 666 regulator with 680 mitered gear assembly where right angle turn is necessary. Blade lengths 19 inches and above, similar except 1/2-inch shafts.
   5. End Bearings: For ducts rated to 1 inch WG, open end, Ventlok 607. For ducts rated above 1 inch WG, closed end, Ventlok 609. Exposed ductwork, finished spaces, Ventlock 609. Spring end bearings not allowed.

C. Volume Damper Fabrication:
   1. Single blade dampers reinforced or crimped for rigidity, with pivot rod extending through duct. Dampers over 12 inches high use multiple opposed blade damper. Single blade damper no larger than 12 inches x 48 inches. Multiple blade damper factory fabricated, Ruskin MD-35 or equal.
   2. Minimum gauge and duct construction in accordance with SMACNA “HVAC Duct Construction Standards”, latest edition.
   3. Splitter and butterfly dampers fabricated of 18 gauge galvanized steel.
   4. Dampers of length suitable to close branch ducts without damper flutter.
   5. Damper blade must be aligned with handle and index pointer.

D. Flexible Equipment Connections: 30 oz. Ventfabrics Ventglas or Duro Dyne neoprene coated fire retardant glass fabric or approved equal.

E. Duct Sealer:
   1. Based On: McGill Airseal Zero.
   2. Description: Suitable for indoor/outdoor use, rated to 10-inch WG, Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 30 g/L less water. SCAQMD Rule 1158 compliant.

F. Duct Tape for Sheet Metal: ARNO C520 duct tape similar United, Duro Dyne, Nashua, Polymer Adhesive.

G. Tape and Adhesive/Activator System for Sheet Metal: Hardcast, Polymer Adhesive.

H. Turning Vane Assemblies:
   1. Sheet Metal Vanes: Multiple radius hollow vane air foil type 2-inch (small vane) or 4-1/2-inch (large vane) inside radius, galvanized steel construction.
   2. Runners: Push-on type.
   3. Acoustical Vanes: Multiple radius air foil type, perforated steel construction with fiberglass fill. AirSan Acoustiturn or as approved.

I. Access Doors:
   1. Manufacturer: Air Balance, Ruskin, Metco, Durodyne, Cesco, Nailor-Hart or approved equal.
   2. Doors complete with steel frame, steel door with backing plate, cam latches (two on units 14-inch x 14-inch and larger), hinge and gasketing. Doors on insulated or lined ducts shall be insulated.
   3. Grease Duct Access Door: Construct of metal thickness equal to metal duct, doors air and grease tight with hinge and hand operable latches. Ductmate.

4. Size:

Duct Width or Duct Diameter	Net Access Door Opening
Up to 8"	6" x 6"
9" to 12"	8" x 8"
13" to 20"	12" x 12"
21" to 30"	16" x 14"
31" to 42"	18" x 14"
Over 42"	Two 16" x 14"

J. Backdraft Dampers:
   1. Manufacturer: Air Balance, Ruskin, Cesco, Advanced Air, Nailor-Hart, Pottorff, or approved equal.
   2. Description: Gravity operated, vinyl edged, metal bladed backdraft dampers.

K. Drip Pans: Provide Type 304 stainless steel drip pans for cooling coils and exhaust heat recovery coils on built-up units as indicated.

L. Louver Blank-off Panels: At air intake or exhaust louvers which are only partially active area, blank off inactive area with sheet metal closure panels caulked airtight, secured to louver frame and insulated with 2" rigid fiberglass insulation per Section 23 07 00 Insulation for HVAC.

M. Roof Jack: Enamel finish steel with back draft damper and bird screen. Broan 636, or equal.

N. Automatic Dampers:
   1. Description: Multi-blade air foil type, except where either dimension is less than 10 inches a single blade may be used. Maximum blade length to be 48 inches. Provide parallel blades for positive or modulating mixing service and opposed blades for throttling service. Blades to be interlocking, minimum 16 gauge galvanized steel.
   2. Dampers shall have compression type edge seals and side seating stops. Damper blades shall be reinforced, have continuous full length axle shafts, axle to axle linkage and/or operating "jackshafts" as required to provide coordinated tracking of all blades. Dampers over 25 square feet in area to be in two or more sections, with interconnected blades. Dampers shall have a maximum air leakage of 3 cfm per square foot at 1 inch wg pressure. Provide all automatic dampers except those specified to be provided with units. Tested in accordance with AMCA Standard No. 500. Based on Ruskin CD-60.
   3. Damper Operators: Refer to Section 23 09 00.
   4. Manufacturers: Ruskin, Air Balance, Cesco, Pottorff or equal.

2.2 FIRE AND SMOKE DAMPERS

A. Acceptable Manufacturers: Where Ruskin is the only manufacturer indicated, equivalent products may be furnished.

B. Static Fire Dampers:
   1. Code Compliance: Provide static fire dampers with a U.L. 555 label for fire rating indicated and in conformance with NFPA 90A.
   2. Dampers shall be integrally hinged, folding blade curtain type, for installation in ductwork complete with 160°F fire link and retainer.
   3. Dampers shall be suitable for horizontal or vertical installation as required. Furnish stainless steel closure springs and cam lock for complete damper closure on dampers to be installed in vertical air flow positions.
   4. Low pressure, 1-1/2-hour: For use in partitions up to 2-hour rating with damper out of air stream for supply.
      a. Ruskin Model IBD2 Style B for supply.
      b. Ruskin Model IBD2 Style A for return or exhaust.

5. Low pressure, 3-hour: for use in partitions over 2-hour rating with damper out of air stream for supply.
   a. Ruskin Model IBD23 Style B for supply.
   b. Ruskin Model IBD23 Style A for return or exhaust.
6. Transfer grilles, 1-1/2-hour: 7/8-inch deep for use in partitions up to 2-hour rating. Ruskin Model IBDT "Thinline".

C. Combination Fire and Smoke Dampers:
1. Multiblade damper with linkage, extended control rod and damper operator with UL Fire Damper Label. Provide round or oval duct connections where required. Operator to be factory-installed, electric type, 120V with spring return to closed position. Stall type motors are not acceptable.
2. Low pressure, 1-1/2 hour: for use in partitions up to 2-hour rating. Ruskin Model FSD36.
3. Low pressure, 3-hour: for use in partitions over 2-hour rating. Ruskin Model FSD60-3.
4. Provide factory installed and wired U.L. Listed duct smoke detector for 0-3000 fpm flow, Ruskin Model DSDN as part of assembly. Provide contactor from smoke detector to fire alarm system.
5. Actuator: Belimo or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all devices as shown on the Contract Drawings and per manufacturer's recommendations.

B. Low Pressure Duct Accessory installation specified under Section 23 33 01.

C. Fire Dampers:
1. Install dampers in accordance with NFPA 90A and manufacturer's written recommendations.
2. Size and locate dampers as shown on Drawings.
3. Install dynamic fire dampers in correct position with regards to direction of air.
4. Where dampers are not accessible for servicing by removing an outlet, provide access doors for servicing. Doors shall be compatible with the duct in which they are installed.

D. Combination Fire and Smoke Dampers:
1. Install dampers in accordance with NFPA 90A and manufacturer's written recommendations.
2. Size and locate dampers as shown on Drawings.
3. Where dampers are not accessible for servicing by removing an outlet, provide access doors for servicing. Doors shall be compatible with the duct in which they are installed.

E. Access Doors: Install where indicated and at all duct mounted coils, automatic control dampers, fire dampers, to provide access for cleaning and maintenance.

F. Kitchen Grease Duct Access Doors: Install every 10 feet and at each change in direction of kitchen exhaust duct per code.

G. Back Draft Dampers: Install where indicated and at the discharge (or inlet) of exhaust fans where automatic dampers are not indicated.

H. Automatic Dampers: Install where indicated and are not specified with equipment. Coordinate damper operators with controls subcontractor.

I. Drip Pans: Install under each cooling coil as indicated. Provide drain connection from each drip pan and pipe to nearest floor drain through trap. Drip pans over 6 feet in length require drain connections from both ends. Pitch drip pans in direction of air flow and to drain.

J. Louver Blank-off Panels: Install blank-off panels on unused portions of louvers.

END OF SECTION

HVAC FANS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Roof exhaust fans, in-line fans, propeller fans, roof vents.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop Drawings: Showing dimensions, details of construction.
   2. Product Data: Showing performance of fans.
   3. Operation and maintenance data.
   4. Submit certified sound power ratings for each fan.

PART 2 - PRODUCTS

2.1 ROOF EXHAUST FANS

A. Acceptable Manufacturer:
   1. Cook, Carnes, Penn-Barry, Acme, Twin City.
   2. Other Manufacturers: Submit Substitution Request.

B. General Description: Provide curb mounted centrifugal roof exhauster.

C. Fans:
   1. Single width, single inlet, airfoil blades as indicated.
   2. One piece heavy gauge spun aluminum construction;Low silhouette type with arched heavy gauge galvanized hood, steel inlet bell, arranged for curb mounting.
   3. Kitchen grease exhaust fans upblast vertical discharge type, with NFPA restaurant installation curb. Units shall be designed for use in kitchen hood applications with motor located outside the air stream. Provide non-sparking wheel assembly and scroll drain.
   4. Statically and dynamically balanced in the factory as an assembly within its own bearings with a maximum full amplitude shaft deflection at bearings not to exceed 0.003-inch at 1200 RPM to meet ANSI S 2.19 G6.3 balance quality grade.
   5. Grease packed pillow block sealed bearings with not less than two pillow blocks per fan assembly.

D. Motor: Integrally mounted, 1800 rpm maximum, with pre-lubricated sealed ball bearings. Refer to Section 23 05 00 for energy efficient motor requirements. Provide EC motor where indicated.

E. Belt Drive: Sized for 150% of motor horsepower, cast iron adjustable sheaves, V-belt type, sheaves statically and dynamically balanced, multiple belt drive on all units over 2 HP. For fans used as part of a life safety system, provide 1.5 times the number of belts required, with a minimum of 2.

F. Direct Drive: Direct drive, where indicated, matched to fan loads.

G. Fan wheel and motor mounted on integral double deflection neoprene isolators.

H. Accessories: Bird screen, disconnect switch under enclosure roof curb, hinged cap for access to damper. Account for roof slope to provide level mounting service for equipment. Curb height shall account for roof insulation depth and flashing requirements.

I. Provide automatic motorized control damper (except grease exhaust), aluminum blades with felt edges.

2.2 INLINE CENTRIFUGAL FANS

A. Acceptable Manufacturers:
   1. Cook, Penn, Acme, Carnes, Twin City.
   2. Other Manufacturers: Submit Substitution Request.

B. General Description: Inline centrifugal, belt or direct driven, cabinet fan, AMCA rated, backward inclined wheel, heavy gauge steel housing adequately braced with all edges sealed, externally mounted 1800 rpm motor, hinged access doors. Refer to Section 23 05 00 for energy efficient motor requirements. Provide disconnect switch.

C. Belt Drive: Multiple belt with fixed sheave and OSHA approved metal guard. Size drive for 150 percent of motor horsepower. For fans used as part of a life safety system, provide 1.5 times the number of belts required, with a minimum of 2.

D. Direct Drive: Manufacturer's EC motor.

E. Vibration Isolation: Provide vibration isolation as indicated on drawings and in accordance with Section 23 05 48.

2.3 PROPELLER FANS

A. Acceptable Manufacturers:
   1. Carnes, Penn, Cook, Acme, American Coolair, Aerovent, Twin City.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Axial flow panel mounted sidewall propeller fan, belt drive, belt guard, OSHA approved screens, and automatic motor operated control damper, supply or exhaust as indicated, weatherhood with bird screen where indicated.

C. Motor: 1800 rpm maximum, pre-lubricated, sealed ball bearings. Refer to Section 23 05 00 for energy efficient motor requirements.

D. Drive: Sized for 150% motor horsepower, adjustable sheaves, v-belt drive. For fans used as part of a life safety system, provide 1.5 times the number of belts required, with a minimum of 2.

2.4 ROOF VENT

A. Acceptable Manufacturers:
   1. Cook, Carnes, Penn, Acme, Twin City.
   2. Other Manufacturers: Submit Substitution Request.

B. General Description: Heavy gauge galvanized steel, low silhouette, roll formed rib sections, exterior baked enamel finish with interior grey prime coat, suitable for curb mounting, with bird screen and automatic motorized control damper. Account for roof slope to provide level mounting service for equipment. Provide hinged cover.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide flexible connections on all inlet and discharge duct connection. Flexible connection for vane axial fans to be barium loaded vinyl.

3.2 ROOF EXHAUST FANS

A. Mount fan on roof curb in accordance with the manufacturer's recommendations. Anchor fan to curb and curb to roof. Coordinate roof opening size and curb location.

B. Connect ductwork.

3.3 PROPELLER FANS

A. Mount fan where indicated.

B. Provide access door on both the motor and discharge side, of adequate size for service and repair.

3.4 INLINE CENTRIFUGAL FAN

A. Mount in ductwork using Vibration Isolation as specified in 23 05 48, and as indicated on drawings.

B. Connect ductwork using flexible connections.

C. Arrange for unobstructed access to access door.

3.5 ROOF VENT

A. Mount roof vent on roof curb in accordance with the manufacturer's recommendations. Anchor roof vent to curb and curb to roof. Coordinate roof opening size and curb location.

B. Make ductwork connections.

END OF SECTION

AIR TERMINAL UNITS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Terminal Units.

1.3 QUALITY ASSURANCE

A. Select units for sound levels, maximum pressure drops, and maximum inlet velocity as specified.

1.4 SUBMITTALS

A. Submit the following:
   1. Catalog data, construction details, and performance characteristics for each type and size of terminal unit.
   2. Data showing compliance with discharge and radiated sound power level specified.
   3. Provide computer calculations for heating coils supplied with unit.
   4. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 SINGLE DUCT CONSTANT OR VARIABLE VOLUME TERMINAL UNITS

A. Acceptable Manufacturers:
   1. Carnes, Titus, Trane, Price, Tuttle and Bailey, Nailor,Anemostat, Krueger.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Single duct, medium velocity, pressure independent, variable volume.

C. Constructed of minimum 22 gauge galvanized steel. Construction to be leakproof with all joints sealed and all access doors gasketed. Leakage rate to be 15 cfm at 3.0" differential S.P. Provide access door for cleaning of coil as an integral part of the unit. Interior lined with coated dual density or matt faced insulation meeting NFPA 90A requirements with lining in accordance with U.L. l8l.

D. Volume Regulator Assembly (DDC Controls):
   1. Controller and actuator provided by 23 09 00 field mounted in NEMA 1 enclosure.
   2. Provide averaging type velocity sensor utilizing multiple sensing points.
   3. Air valves all metal construction, non-corrosive, with bearings self-lubricating and moving parts replaceable in the field.
   4. Assembled unit tested, factory preset, and guaranteed to provide ±5% total maximum air flow rate through an inlet pressure range to 3.0 inches water.

E. Air static pressure drop across terminal unit not to exceed 0.35-inch W.G. without coil. Maximum inlet duct velocities shall not exceed 2200 fpm.

F. Sound ratings shall be tested as power level l0-l2 watts in accordance with ARI/ADC 880 standard and ASHRAE Standard 36B-72 at 1.5-inch W.G. inlet static pressure. Unit discharge airborne and casing radiated sound not to exceed following rated sound power levels:

MAXIMUM AIRBORNE SOUND POWER (db)							
	OCTAVE BAND & CENTER FREQUENCY (HZ)						
CFM	63	125	250	500	1K	2K	4K
0 - 300	--	63	64	60	60	60	52
301 – 400	68	65	65	63	60	60	52
401 – 800	71	68	67	67	60	60	52
801 – 1200	73	72	68	67	60	60	52
1201 – 2000	73	75	69	67	60	60	54
2001 and above	--	80	78	76	67	67	60
* Units must have 5-feet of 2-inch thick lined duct or 3-feet 0-inch IAC MS sound trap provided with unit at units discharge to meet acoustic design goals							

MAXIMUM RADIATED SOUND POWER (db)							
	OCTAVE BAND & CENTER FREQUENCY (HZ)						
	1	2	3	4	5	6	7
CFM	63	125	250	500	1K	2K	4K
0-2000 2001 and above*	71	68	61	61	55	55	50
* Units must have loaded vinyl wrap over 2-inch thick insulation							

G. Water Heating and Cooling Coils: See Section 23 82 00 for specification. Coils shall be installed remotely in ductwork downstream of terminal unit.

PART 3 - EXECUTION

3.1 INSTALLATION, TERMINAL UNITS

A. Support terminal units from structure using thread rod and brackets provided. Provide vibration isolation as indicated on plans, and as specified. Make a rigid duct connection to the inlet with minimum length of straight duct upstream of unit as recommended by the manufacturer or as noted whichever is greater.

B. Refer to Section 23 07 00 for duct lining requirements at outlet of terminal units. Maintain 3 feet clear in front of control enclosure.

C. Arrange units for operation with control system. Coordinate with the work specified in Section 23 09 00.

D. Provide a minimum of 5-feet of ductwork prior to first outlet branch duct takeoff.

E. Install terminal unit to allow for complete access to controls, and all items requiring maintenance or adjustment.

F. Mount terminal unit controller, actuator to primary air valve, coil connections, control valve, and piping specialties on the same side of the terminal unit.

END OF SECTION

AIR OUTLETS AND INLETS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Ceiling diffusers, sidewall grilles.

B. Related Sections include:
   1. Section 23 33 00 Duct Accessories.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop Drawings: Showing dimensions and details of construction.
   2. Product Data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Where only Titus figure numbers are listed, equivalent products by Carnes, Price, Krueger, Tuttle & Bailey, Anemostat, Nailor are acceptable.

B. All such products shall be of one manufacturer.

C. Other Manufacturers: Submit substitution Request.

2.2 PERFORMANCE

A. Unit sizing is based on air being introduced at 20°F temperature differential and being diffused at the 5-foot level to a velocity not greater than 50 FPM and a temperature differential not greater than 1.5°F. Units are also selected so as not to exceed the NC-30 curve.

2.3 DIFFUSERS AND GRILLES

A. Ceiling Supply Diffuser (C-1): Modular diffuser with adjustable modular core, steel panel, square or rectangular neck size as indicated, discharge pattern as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), white baked enamel finish, Titus MCD.

B. Ceiling Return/Exhaust Grille (C-2): 1/2 x 1/2 x 1/2-inch egg crate grille, neck size as indicated, aluminum construction, baked white enamel finish, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), Titus Model 50F

C. Ceiling Supply Diffuser (C-3): Round ceiling diffuser, adjustable horizontal and vertical discharge pattern, round neck size as indicated, steel construction, baked white enamel finish, Titus TMRA.

D. Slot Diffuser (S-1): Slot diffuser with quantity, length, and width of slots as scheduled, adjustable pattern controller, two pattern control blades per slot in lengths greater than 36-inches, inlet sizes as indicated, plenum lined with 1/2-inch insulation, unit furnished with center tee, baked enamel finish, color to match ceiling grid, Titus TBDI-10.

E. Slot Return (S-2): Same as S-1 but without pattern controller; four foot length.

F. Wall Supply Grille (H-1): Adjustable aluminum double deflection blades, horizontal front with vertical rear blades, 3/4-inch spacing, 1-1/4-inch border, gasketed around face flange, white baked enamel finish, Titus Model 272FL.

G. Wall Return/Exhaust Grille (H-2): Aluminum 45 degree fixed single deflection, horizontal blades 3/4-inch spacing 1-1/4-inch border, gasketed around face flange, white baked enamel finish, Titus Model 3F.

H. Wall Return/Exhaust Grille (L-1): Aluminum perforated face, 3/16" holes staggered on ¼" centers. 1-1/4-inch border, gasketed around face flange, white baked enamel finish, Titus Model 8R

I. Wall Return/Exhaust Grille (L-2): Heavy duty bar grille, steel 38 degree fixed single deflection, horizontal 14 gauge blades, 1/2-inch spacing, 1-1/4-inch 16 gauge border, steel support bars spaced on 6-inch center. Provide intermediate mullions as required for large grilles. White baked acrylic finish, Titus 33RL or 33RS as required for blades to be parallel to floor.

J. Drum Louver (H-3): Drum louver with 1-1/4-inch steel borders, (opposed blade dampers), counter sunk screw holes, extruded aluminum drum, rotatable 25 degrees up/down form centerline, individually adjustable blades, white baked enamel finish, Titus model DL.

K. Wall Relief/Transfer Grille (H-4): Aluminum 0 degree fixed single deflection, horizontal blades 3/4-inch spacing 1-1/4-inch border, gasketed around face flange, white baked enamel finish, Titus Model 350ZFL.

L. Duct Mounted Supply Grille (H-5): Aluminum orbital nozzle diffuser, 360 degree rotation, +/- 35 degree deflection, duct mounted faceplate. Air Concepts APL, Seiho PK, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all diffusers tight to their respective mounting surfaces.

B. Installed plumb and true with room dimensions and accurately centered on projections as shown on the Architectural reflected ceiling plans.

C. Install extractors behind all duct mounted sidewall supply grilles, and where shown. Turning vanes allowable if condition is the last outlet on a branch.

D. Set pattern control for directions of throw as shown on Drawings prior to air balancer arriving on Project.

E. Paint ductwork behind all outlets flat black.

END OF SECTION

HVAC AIR CLEANING DEVICES

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Air filter assemblies.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop Drawings: Details of construction and dimensional data.
   2. Product Data: Air filters, gauges, including performance data.
   3. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MEDIUM EFFICIENCY PLEATED FILTERS

A. Acceptable Manufacturers:
   1. Camfil-Farr 30-30, Cambridge, American Air Filter, Eco-Air Products, Flanders Precisionaire.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: 2-inch thick medium efficiency, pleated fabric media disposable type filter with support grid and enclosing frame. U.L. Class 2. Size as indicated on drawings.

C. Rating: 25-30% MERV 7 efficiency rated on ASHRAE Standard 52.1-1992 and 52.2-1999 respectively.

D. Performance: Filters shall be capable of maintaining rated efficiency at 500 fpm face velocity with initial pressure drop not to exceed 0.30" WG and final pressure drop at 0.90" WG.

E. Frame: Provide complete factory assembled galvanized steel frame assembly suitable for filters, including all necessary hardware for supporting and holding filters in place with an air tight seal all around frame, side access on air handling units.

2.2 CARBON PLEATED FILTERS

A. Acceptable Manufacturers:
   1. Flanders FCP, Camfill-Farr, American Air Filter, Eco-Air Products
   2. Other Manufacturers: Submit Substitution Request.

B. Description: 2-inch thick pleated activated carbon filled nonwoven polyester media sealed within a moisture resistant board frame. Carbon granules to be thermally bonded to the fibers.

C. Rating: 30 x 50 US Mesh granules with carbon tetrachloride rating of 90%.

D. Performance: Capable of removing toluene at an efficiency of 90% at inlet concentration of 10 ppm and a filter face velocity of 500 fpm.

2.3 FILTER GAUGE

A. Acceptable Manufacturers:
   1. Dwyer No. 2002-ASF.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Magnehelic gauge with plastic vent valves, adjustable signal flag, external front screw for zero adjustment.

C. Accessories: Pressure tap plugs, static pressure tips, tubing, mounting adapters with screws.

D. Range: 0 to 2 inches W.G., with 0.05-inch divisions.

2.4 EXTRUDED ALUMINUM FILTER FRAMING MODULE

A. Acceptable Manufacturers:
   1. Eco-Air “K-Trac”, Camfil-Farr, Cambridge.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Factory design Type 6063-T6 mill finish extruded aluminum modules. Factory cut to length, pre-drilled and gasketed for quick field assembly. No clips or filter fasteners required.

C. Filter Track: 2-inch wide pre-filter track with 1-1/4-inch wide final filter track in one extrusion. Permanently gasketed to eliminate air bypass. Spring loaded sealing lever shall actuate a pressure bar to positively seal final filter header in track.

D. Performance: Capacities as shown on drawings [or specify here].

2.5 SIDE ACCESS FILTER HOUSING

A. Acceptable Manufacturers:
   1. Eco-Air “Surepleat”, Camfil-Farr, Cambridge, American Air Filter.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Factory assembled, 16 gauge galvanized steel construction. “Z” channel vertical support members on all four corners. Upstream and downstream outwardly turned flanges for connection to air handling unit.

C. Filter Track: Extruded aluminum with a replaceable poly-pro gasket to insure sealing of filters to track. Filter track 2-inches wide.

D. Access Doors: Provide on designated access side of housing with continuous neoprene gasketing. Equip with positive-pressure adjustable latches and easy grip knobs.

E. Performance: Capacities as shown on drawings [or specify here].

PART 3 - EXECUTION

3.1 INSTALLATION, PLEATED FILTERS

A. Arrange for access and removal of filter elements.

B. Install filters in air handling unit filter racks, filter grilles and other locations shown on the plans.

C. Air handling unit or fans shall not be operated without specified filters properly installed.

3.2 INSTALLATION, FILTER GAUGE

A. Install filter gauge around each filter assembly with static pressure taps for entering and leaving side of filter.

B. Fasten all tubing with metal fasteners.

3.3 PROTECTION

A. Equipment Operation During Construction:
   1. Pleated Filters:
      a. Install one set of filters in all air handling equipment for use during construction.
      b. Furnish a spare set of filters for the Owner's use after initial flushout.
   2. Carbon Filters: Install carbon filters in each air handler before building occupancy.

END OF SECTION

BREECHINGS, CHIMNEYS AND STACKS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Condensing Boiler Burner Breeching and Stack

B. Related Sections include:
   1. Section 23 52 00 Heating Boilers.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop drawings showing details of construction.
   2. Product data showing performance data.
   3. Sizing analysis of each system.

PART 2 - PRODUCTS

2.1 CONDENSING BOILER BURNER BREECHING AND STACK

A. Acceptable Manufacturers:
   1. Heat-Fab, Saf T Vent Plus, ProTech Systems FasNSeal, Metal Fab, Schebler EVentSD.
   2. Other Manufacturers: Submit Substitution Request..

B. Provide factory built modular connector, double wall, manifold, and stack system complete with tall cone flashing, ventilated thimble, storm collar, rain cap, and complete mounting hardware including mounting bracket, guy wires, and anchor plates.

C. System to be Underwriters Laboratories approved for use with Category III and IV heating equipment which produce exhausted flue gases at temperature not exceeding 480 degrees Fahrenheit (F) under continuous operating conditions when burning gaseous fuels. The stack system designed and installed to be gas tight to prevent leakage of combustion products. System designed to compensate for all flue gas induced thermal expansions.

D. Stack system constructed of inner gas carrying pipe of type AL29-4C stainless steel and outer jacket of 430 stainless steel with a 1-inch air space between the walls.

E. Inner pipe joints sealed by use of factory supplied V Bands and sealant as specified in manufacturer's installation instructions.

F. Roof penetrations suitable for type of roof system used and according to manufacturer’s detail drawings and installation instructions. Extend stack above roof as required by local codes and as indicated.

PART 3 - EXECUTION

3.1 APPLIED LOCATIONS

A. Condensing Burner Breeching and Stack:
   1. Condensing Boilers.

3.2 INSTALLATION

A. Install where shown on drawings and where specified in accordance with manufacturer's recommendations.

B. Coordinate sealing of wall penetrations with work specified in Division 7.

C. Maintain minimum clearances as required by code and by manufacturer.

D. Support stack horizontally and vertically from structure.

E. Provide adjustable length fittings to compensate for thermal expansion.

F. Supports shall be braced to resist movement.

G. Generally support stack at bottom and at changes in direction. Intermediate supports to allow for movement.

H. Stack shall not be supported by the equipment.

END OF SECTION

HEATING BOILERS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Boiler burner unit.
   2. Gas fired condensing boiler unit.

B. Related Sections include:
   1. Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.
   2. Section 23 31 01 HVAC Ducts and Casing – Low Pressure.
   3. Section 23 51 00 Breechings, Chimneys and Stacks.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop drawings showing details of construction.
   2. Product data showing performance data.
   3. Field Test Reports:
      a. Provide copy of start-up report, including copies of combustion analyzer and efficiency printouts performed at low and high-fire during initial boiler start-up.
      b. Provide copy of installation compliance report for ASME CSD-1.

B. Operating and Maintenance Data.

1.4 TRAINING

A. Provide on-site operation and maintenance training for (2) identical 4-hour sessions. Coordinate training times with the Owner.

B. At the sessions include troubleshooting, repair and maintenance manuals for maintenance personnel. Coordinate quantity required with the Owner.

PART 2 - PRODUCTS

2.1 NATURAL GAS FIRED CONDENSING BOILER UNIT (B-1)

A. Acceptable Manufacturers: Lochinvar Crest Model FB

B. Other Manufacturers: Submit Substitution Request.

C. Furnish packaged condensing gas fired type hot water boiler complete, listed by CSA International under latest edition of ANSI Z21.13. Boiler shall be manufactured in accordance with appropriate ASME Heating Boiler Code, stamped for 160 psi water working pressure. Boiler shall be complete with modulating power burner, controls, insulated metal jacket, integral base supports and accessories. Furnish steel jacket with baked enamel finish and minimum of 2-inches medium density fiberglass insulation. Capacity as indicated on drawings.

D. Heat Exchanger: 316L stainless steel, fire tube style; single pass, flow through.

E. Combustion blower: Variable speed.

F. Combustion chamber: Completely sealed and enclosed, independent of outer jacket assembly.

G. Stainless steel burner shall be pre-mix design, capable of minimum (2,000 MBH unit 25:1) turndown of firing rate without loss of combustion efficiency. Boilers shall be capable of standalone operation in the event of a control system failure.

H. Water boiler trim and accessories to include burner/flame observation port, low water cut off, drain valve, combination thermometer and pressure gauge, thermistor supply and return water temperature sensor (pre-installed), system supply header temperature sensor (furnish for field installation), flue temperature sensor, , ASME rated safety relief valve(s), drain tapping and condensate draines.

I. Gas Train: UL/FM or CSA approved, safety shut-off valve, air/fuel valve, gas pressure regulator (2 psi is available at the gas train), and nozzle-mix stainless steel burner. Furnish flame monitoring system, and CSD-1 gas manifold control package.

2.2 CONTROLS

A. Provide 24 volt operating controls and safety devices for automatic operation. Controls to include operating controller, touch-screen display, manual reset high temperature limit, electronic flame safeguard control, control circuit transformer, manual reset low water cutoff, and blower motor starter on forced draft units, hi/low gas pressure switch, master switch, airflow switch, water flow switch. Unit shall be factory prewired and include operating indicating light, and alarm bell, single point electrical connection in NEMA 1 enclosure. Electrical characteristics as indicated. Provide all necessary field wiring for a complete system. Microprocessor flame safeguard programmer with first-out fault annunciation and diagnostic indicator lights. Provide alarm dry contact for interface to building DDC control system. Boiler shall allow 0-10VDC input connection to DDC system. Provide BACnet card for communications.

B. Multiple Boiler Sequencing Control Panel: Provide as part of the packaged boiler control system, a microprocessor based lead-lag sequencing system. The control shall be pre-engineered and programmed exclusively for the operation of multiple hot water full modulation boilers. The controls shall permit interface with building DDC control system. Control system shall be in U.L. listed panel.

C. Multiple Boiler Sequence of Operation: Upon call for heating, start the primary boiler at low fire and modulate capacity to meet setpoint temperature. When the primary boiler is above its low firing capacity for 10 minutes (adjustable), the secondary boiler shall be started and both boilers shall operate in unison at the same firing capacity. As the heating load diminishes and the boilers reduce their firing rate to low fire for 10 minutes (adjustable), the sequence above is reversed with the primary boiler stopping first. Provide adjustable time delays between boiler sequencing. Alternate the primary boiler weekly to equalize run time.

2.3 AUTOMATIC SHUT OFF VALVE

A. Manufacturer’s 2-way motorized shut off valve and relay kit for each boiler

B. Size: To match boiler connections.

C. Ship valve loose, for field installation.

2.4 VENTING

A. Boilers to be capable of being vented into a conventional stack or “through the wall”.

B. Vent shall be sized in accordance with manufacturer’s installation recommendations.

C. Refer to specification 23 51 00 for venting material requirements.

2.5 COMBUSTION AIR

A. Boilers to receive combustion air by direct venting.

B. Refer to specification 23 31 01 for combustion air ducting material requirements.

2.6 EMISSIONS

A. Boiler emissions must be within those allowed by the DEQ.

2.7 CONDENSATE MANAGEMENT SYSTEM

A. Provide neutralizer kit to assure any condensate discharge is controlled to a pH range of 6.5-7 before discharge into the drainage system. Use materials approved by the authority having jurisdiction. Provide Owner with a one year supply of condensate neutralizer (reagent grade calcium carbonate). Based on: JJM Boiler Works JM Series.

2.8 WARRANTIES

A. Provide 10 year warranty on heat exchanger and burner to include full replacement covering all parts and labor. Burner to be warranted against burner clog or burn out.

B. Provide 1 year on all parts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's instructions for installation.

B. Boiler: Install in accord with manufacturer's recommendation to provide adequate clearance and accessibility. Mount on 4-inch concrete housekeeping pad. Pad size per boiler manufacturer's instructions. Install necessary drains and safety valve, as required for a complete installation.

C. Pipe valved drain from boiler to nearest floor drain.

D. Connect ICW to condensate receiver.

E. Pipe hot water boiler relief valve outlet to floor.

F. Install feed water regulating valve with required piping, valves, strainer, check valve, manual bypass valve as indicated.

G. Drawings indicate a location of boiler flue based on assumption. If boilers supplied have different flue gas location, contractor shall redesign and relocate stack at no additional cost.

H. While Owner is responsible for all DDC controls and wiring, Contractor shall provide raceway and cascade communication wiring between boilers, and from boilers to common supply header temperature sensor and automatic shutoff valves.

3.2 START-UP

A. General: Comply with manufacturer’s instructions for start-up.

B. Start-up shall be provided under the direct supervision of the manufacturer’s representative.

C. At completion of start-up submit written record of startup performance including percent CO2, CO, and O2, stack temperature, and combustion efficiency.

D. Manufacturer representative shall demonstrate operation of all controls, interlocking, and flame safeguard.

3.3 CLEANING

A. After installation and before start-up thoroughly clean boilers of scale, grease, etc. and boil out in manner and for duration as recommended by manufacturer.

3.4 INSPECTION

A. Subject boiler to hydrostatic pressure test in presence of authority having jurisdiction. Tests shall conform to ASME Boiler Code and other applicable codes.

END OF SECTION

PACKAGED WATER CHILLERS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Air-cooled water chiller.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop Drawings showing complete details of construction.
   2. Catalog data showing performance data.
   3. Part load operating characteristics and application part load value calculation (APLV) per ARI Standard 550-88.
   4. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 AIR COOLED WATER CHILLER

A. Acceptable Manufacturers:
   1. Daikin Applied, JCI, Carrier, Trane.
   2. Other Manufacturers: Submit Substitution Request.

2.2 UNIT DESCRIPTION

A. Factory-assembled, factory-charged air-cooled scroll compressor packaged chiller consisting of hermetic tandem or triple scroll compressor sets, direct expansion, shell-and-tube evaporator air-cooled condenser section, microprocessor-based control system and all components necessary for controlled unit operation.

B. Factory run-test with water to verify full-load operation. Operating controls and refrigerant charge shall be verified for proper operation and optimum performance. Any deviation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments.

2.3 DESIGN REQUIREMENTS

A. Performance: As scheduled. The chiller shall be capable of stable operation to a minimum percentage of full load (without hot gas bypass) of 25% for units 130 tons and less and 17% for units over 130 tons. Performance shall be in accordance with AHRI Standard 550/590.

2.4 CHILLER COMPONENTS

A. Compressor: Sealed hermetic, scroll type with crankcase oil heater and suction strainer. Motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads. The 20 – 40 ton compressors shall be equipped with an internal module providing compressor protection and communication capability.

B. Evaporator
   1. Type: Direct expansion, U-tube with water flowing in baffled shell side and refrigerant flowing through tubes. Two independent refrigerant circuits within the evaporator serve the unit's dual refrigerant circuits.
   2. Construction: Carbon steel shell and seamless high efficiency copper tubes roller-expanded into a carbon steel tube sheet. The top and bottom of the evaporator shall have ½ inch vent and drain plugs.
   3. Freeze Protection: Electric resistance immersion heater, insulated with ¾ inch thick vinyl nitrate polymer sheet insulation and with K-factor of minimum 0.28 at 75°F protecting against water freeze-up at ambient air temperatures to -20°F. A fluid thermostat shall control the heater.
   4. Certification: Water side working pressure shall be 152 psig, designed, constructed, inspected, and stamped according to the requirements of the ASME Boiler and Pressure Vessel Code.

C. Condenser
   1. Coils: 3/8 inch seamless copper tubes mechanically bonded into plate type fins. Fins shall have full drawn collars to completely cover the tubes. A subcooling coil shall be an integral part of the main condenser coil.
   2. Fans: Single piece, composite, propeller type arranged for vertical air discharge and individually driven by direct drive fan motors. Each fan shall be in its own compartment to eliminate cross flow of condenser air during fan cycling and shall be equipped with a heavy-gauge vinyl coated fan guard.
   3. Motors: Weather protected, three-phase, direct-drive, 1140 rpm, TEAO type with permanently lubricated ball bearings and inherent overload protection. External coil surfaces shall have wire mesh protective guards.
   4. Fins: Rippled aluminum.

D. Refrigerant Circuit: Each refrigerant circuit shall include a replaceable-core refrigerant filter-drier, sight glass with moisture indicator, liquid line solenoid valve (no exceptions), thermal expansion valve, and insulated suction line.

E. Construction
   1. Unit casing and all structural members and rails: Fabricated of steel and painted to meet ASTM B117, 500-hour salt spray test.
   2. Upper condenser coil section of unit: Protective, 12 ga, PVC-coated, wire grille guards.

F. Control System
   1. Control Panel: Centrally located weatherproof control panel shall contain the field power connection points, control interlock terminals, and control system. Power and starting components shall include factory circuit breaker of fan motors and control circuit, individual contactors for each fan motor, solid-state compressor three-phase motor overload protection, inherent fan motor overload protection and two power blocks (one per circuit) for connection to remote, contractor supplied disconnect switches. Hinged access doors shall be lockable. Barrier panels or separate enclosures are required to protect against accidental contact with line voltage when accessing the control system.
   2. Connection: Single-point connection to a non-fused disconnect switch with through-the-door handle and compressor circuit breakers.

G. Unit Controller: DDC microprocessor unit controller with 4-line by 20-character liquid crystal display provides. The controller shall take pre-emptive limiting action in case of high discharge pressure or low evaporator pressure.
   1. Equipment Protection:
      a. By alarms that shut the unit down and require manual reset to restore unit operation and
      b. By limit alarms that reduce unit operation in response to some out-of-limit condition. Shut down alarms shall activate an alarm signal.

2. Shutdown Alarms
    a. No evaporator water flow (auto-restart)
    b. Sensor failures
    c. Low evaporator pressure
    d. Evaporator freeze protection
    e. High condenser pressure
    f. Outside ambient temperature (auto-restart)
    g. Motor protection system
    h. Phase voltage protection (Optional)
3. Limit Alarms
    a. Condenser pressure stage down, unloads unit at high discharge pressures.
    b. Low ambient lockout, shuts off unit at low ambient temperatures.
    c. Low evaporator pressure hold, holds stage #1 until pressure rises.
    d. Low evaporator pressure unload, shuts off one compressor.
4. Unit Enable Selection
    a. Enables unit operation from either local keypad, digital input, or BAS
5. Analog Inputs:
    a. Reset of leaving water temperature, 4-20 mA
    b. Current Limit
6. Digital Inputs
    a. Unit off switch
    b. Remote start/stop
    c. Flow switch
    d. Motor protection
7. Digital Outputs
    a. Shutdown alarm; field wired, activates on an alarm condition, off when alarm is cleared
8. Condenser fan control - The unit controller shall provide control of condenser fans based on compressor discharge pressure.
9. Building Automation System (BAS) Interface
    a. Factory mounted DDC controller(s) shall support operation on a BAC netnetwork via BACnet MS/TP master (Clause 9), BACnet IP, (Annex J), or BACnet ISO 8802-3, (Ethernet).
    b. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
    c. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

2.5 OPTIONS AND ACCESSORIES

A. The following options are to be included:
    1. BAS interface module to provide interface with the BACnet/IP protocol.
    2. Evaporator inlet strainer, 40-mesh with extension pipe and Victaulic couplings

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer’s instructions for installation.

B. Pipe Connections: Arrange connections to chiller to prevent pipe weight or stresses from being transferred to chiller and to provide easy access for tube cleaning.

C. Water Treatment: Treat chilled and condenser water system as specified.

D. Strainer: Install manufacturer-supplied strainer in chilled water return line at evaporator inlet; 40-mesh on units with brazed-plate evaporators or 20-mesh on shell-and-tube evaporators.

3.2 START UP

A. General: Comply with manufacturer's instructions for startup.

B. Start up shall be provided under the direct supervision of the manufacturer's representative with factory trained personnel.

3.3 FIELD QUALITY CONTROL

A. Prior to installation, manufacturer's representative shall coordinate chiller control interface and verify that intended installation (controls, piping, etc.) complies with the manufacturer's recommendations.

B. Field Test: Except where initial chiller operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests performed by the manufacturer's representative in the presence of the Engineer.

END OF SECTION

CENTRAL HVAC EQUIPMENT

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Air handling units.

B. Related Sections include:
1. Section 23 05 14 Variable Frequency Drives for HVAC Systems
2. Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment: For vibration isolators.
3. Section 23 07 00 Insulation for HVAC: For acoustical liner.

1.3 SUBMITTALS

A. Submit the following:
1. Shop Drawings showing details of construction, dimensions, arrangement of components, and isolation.
2. Product data showing performance data.
3. Operating and maintenance data.
4. Specified testing requirements.

PART 2 - PRODUCTS

2.1 MODULAR INDOOR AIR HANDLING UNITS

A. Acceptable Manufacturers:
1. Aaon M2, McQuay Vision, York Solution, BasX, Trane Climatechanger, Carrier.
2. Other Manufacturers: Submit Substitution Request.

B. Description:
1. Variable volume, single zone draw-through modular air handling units consisting of fan section(s), coil section, filter section, motor(s) and drive(s), and mixing box, all contained in an insulated steel casing and mounted on a common steel base. Arrange components as specified hereafter and as shown on the Drawings.
2. Units shall be Air Moving and Conditioning Association rated.

C. Unit Casing:
1. Casing of 16 gauge steel, properly reinforced and braced and of sectionalized construction. Support entire unit on continuous steel supports.
2. Provide access doors for inspection of fan and motor.
3. Manufacturer’s standard factory finish.
4. Insulation of entire cabinet shall be 2-inch thick minimum, R-8 minimum. Insulation shall be 3 lbs/cubic ft. faced rigid fiberglass insulation or polyurethane foam.
5. Drain pan under cooling coils with 1/2-inch cellular, foam-in place insulation.
6. Arranged with motor and drive inside fan casing; isolated fan and motor assembly within unit casing.

D. Fans:
1. Fan type and capacity as indicated on the drawings.
2. Statically and dynamically balanced in its own bearings with a maximum full amplitude shaft deflection at bearings not to exceed 0.001 inch at 1200 RPM.

3. Grease lubricated, self-aligning, interior mounted pillow block or flanged bearings permanently sealed.
4. Provide spherical roller bearings on units of 25 horsepower and larger, 80,000 hour L-10 life per AFBMA Standards.

E. Motor and Drive:
1. Integrally mounted 1800 rpm motor, with pre-lubricated sealed ball bearings.
2. V-belt drive sized for 150% of motor horsepower, with cast iron fixed sheaves for motors over 5 horsepower, variable pitch drives for motors 5 horsepower and under.
3. Multiple belt drives on units over 2 horsepower.
4. Sheaves statically and dynamically balanced.
5. Refer to Section 23 05 00 for energy efficient motor requirements.
6. Direct-drive ECM motor where indicated.

F. Vibration Isolators:
1. Provide as an integral part of each unit. See Section 23 05 48.
2. Coordinated weights and location of support points with the vibration isolation equipment supplier.

G. Water Coils: See Schedule for capacities and Section 23 82 00 for specification.
1. Provide drain pan for each level of cooling coils. Drain pans constructed from stainless steel or galvanized steel coated with asphalt or approved rust inhibitor.
2. Drain pan shall be double sloped, in direction of air flow and toward drain connection.

H. Filters: See Section 23 40 00 for specification. Provide suitable access doors, slide rack, and sealant strips for filters specified. Additional pleated and carbon filters shall be furnished loose, as described in Section 23 4000.

I. Flexible Connections:
1. Constructed in accordance with U.L. 181, Class I air duct with flanged connections.
2. Flexible, neoprene-coated glass fabric not lighter than 30 oz./sq.yd.
3. "Ventglas" by Vent-Fabrics, Inc.

J. Mixing Boxes:
1. General: Provide multi-blade dampers as shown on Drawings and as required to provide economizer cooling and morning cool-down functions.
2. Provide minimum outside air with slotted damper crank arm adjusted so that damper is closed with the motor shaft retracted and at the minimum flow position with the motor shaft fully extended.
3. Arrange return air and minimum outside air dampers to discharge against each other for maximum mixing in the mixing box prior to the coil.

K. Sound Requirements:
1. The manufacturer shall furnish sound power levels at the supply air connection, return air connection, outside air opening, relief air openings and casing radiation for each air handling unit.
2. Sound power level (re: 10-12 watts) when producing scheduled airflow (CFM) at static pressure shall not exceed following in any octave band:

2.2 SMALL INDOOR AIR HANDLERS

A. Acceptable Manufacturers:
1. Aaon H3, BasX, Thermal Corp.
2. Other Manufacturers: Submit Substitution Request.

B. General Description
1. Indoor air handling units shall include filters, supply fans, chilled water coil, mixing box, and unit controls.
2. Unit shall have a draw-through supply fan configuration and discharge air horizontally or vertically as indicated on drawings.

3. Unit shall be factory assembled and tested including leak testing of the chilled water coil, and run testing of the supply fans and factory wired electrical system. Run test report shall be supplied with the unit.

C. Construction
   1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
   2. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
   3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
   4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
   5. Access to filters, cooling coil, supply fans, and electrical and controls components shall be through hinged access doors.
   6. Access doors shall be flush mounted to cabinetry. Coil access door and supply fan access door shall include quarter-turn lockable handles. Supply fan access door shall include removable pin hinges.
   7. Units with a cooling coil shall include sloped 304 stainless steel drain pan. Drain pan connection shall be on the right hand side of unit.
   8. Cooling coil shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.

D. Electrical
   1. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.
   2. Unit shall be provided with standard power block for connecting power to the unit.
   3. Unit shall include a factory installed 24V control circuit transformer.

E. Supply Fans
   1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
   2. Blower and motor assembly shall be dynamically balanced.
   3. Blower and motor assembly shall be isolated with neoprene gasket.
   4. Motor shall be a high efficiency electronically commutated motor (ECM).

F. Cooling Coil
   1. Chilled Water Cooling Coil
      a. Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.
      b. Coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
      c. Coil shall have right hand external piping connections. Supply and return connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing, to minimize air leakage.

G. Filters
   1. See Section 23 40 00 for specification. Additional pleated and carbon filters shall be furnished loose, as described in Section 23 40 00.
   2. Unit shall include a clogged filter switch.
   3. Unit shall include factory installed Magnehelic gauge measuring the pressure drop across the filter rack.

H. Mixing Box
   1. Unit shall contain a mixing box with top opening and front opening, which may be used for either outside air or return air.
   2. Return air opening shall contain an adjustable, motor operated return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven. Dampers shall be fixed position controlled by a fully modulating actuator.
   3. Outside air opening shall contain an adjustable, motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven. Dampers shall be fixed position controlled by a fully modulating actuator.

2.3 DRAIN PAN LEVEL MONITOR

A. General: Water level monitoring device installed in cooling coil drain pan, to shut off fan if condensate drain line becomes blocked.

B. Components:
   1. Low voltage solid state sensor.
   2. Plenum rated probe and sensor wire
   3. Spare wire for alarm or connection to DDC system.

C. Compliance with IMC 307.2.3.1

D. Manufacturer: Rectorseal Aquaguard

PART 3 - EXECUTION

3.1 INSTALLATION

A. Indoor Air Handling Unit:
   1. Install with air filters in place before operating unit.
   2. Modular air handlers shall mount on steel base which is integral with unit.
   3. Pipe drain pan to floor drain with 3-inch minimum trap seal.
   4. Small air handlers shall be mounted to a minimum of two six inch high wooden sleepers that are themselves secured to floor.

B. Flexible Connections:
   1. Provide flexible connections between fans and the connected ducts or plenums.
   2. Install with 1-inch space between the fan and connecting duct with fabric snug but not stretched tightly.
   3. Provide accurate alignment between fan and duct.
   4. Secure in place with flanged connections. Do not crimp into the duct construction. Ends of the screws shall not project into the duct more than 1/8-inch.

C. Drain Pan Level Monitor
   1. Install per manufacturer’s instructions in each indoor air handler located on mechanical platforms.
   2. Shut down unit down unit directly after a suitable time delay upon detecting blockage.

END OF SECTION

DECENTRALIZED UNITARY HVAC EQUIPMENT

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Split-system air conditioning unit.

B. Related Sections include:
   1. Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop drawings showing details of construction, dimensions, arrangement of components, isolation, filters, etc.
   2. Product data showing performance data, standard items and accessories, operating weight.
   3. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 SPLIT-SYSTEM AIR CONDITIONING UNIT

A. Acceptable Manufacturers:
   1. Carrier, Trane, Lennox, Daikin, JCI.
   2. Other Manufacturers: Submit Substitution Request.

B. Indoor Unit:
   1. Description: Furnish complete unit including cabinet, wall mounting kit and accessories, refrigerant line set, fan and motor assembly, cooling coil and filter. Unit as scheduled on drawing, factory-tested and assembled, factory wired, refrigerant-to-air heat exchanger, fan/motor assembly, compressor, controls and safety devices, control circuit transformer, shipped in one piece with ARI certification and UL listing.
   2. Cabinet: 18 gauge steel, removable panels for access to components. Drain connection and return air filter racks.
   3. Fan and Motor: The evaporator fan shall be an assembly with a turbo fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The fan shall consist of two (2) speeds, High and Low.
   4. Mixing box: Provide manufacturer's standard economizer section with return air and outside air dampers. Outside air dampers to be low-leak per Oregon Energy Code.
   5. Controls: Wiring shall run direct from the indoor unit to the controller with no splices. The system shall be capable of automatic restart when power is restored after power interruption
   6. Condensate Pump: Provide condensate pump when required; pipe drain to floor drain.

C. Outdoor Unit:
   1. Description: Provide air cooled air conditioner (outdoor unit) designed for outdoor installation with factory supplied supports, properly assembled and tested at the factory. Unit shall be completely weatherproofed and include compressor, condenser coils, condensing fans, motor, refrigerant reservoir, charging valve, all controls, and a holding charge of R410A. Provide guards on condenser fans and coil guard.
   2. Compressors: Furnish hermetically sealed type with isolation and sound muffling. Units shall have overload and inherent winding thermostat protection to prevent burn out. Provided crankcase heater. Two-stage compressors.
   3. Refrigeration Circuits: Unit shall include back seating service valve and gauge ports in liquid and suction lines. Provided refrigerant filter-dryer.
   4. Condenser Fans and Motors: Direct driven propeller type fans with permanently lubricated motors.
   5. Controls: Provide high and low pressure cutouts, contractors and internal overload protection on all motors. Provide low ambient operation to 20°F outside to maintain condensing temperature on part load operation. Provide short cycle timer.

D. Controls Interface: The control system shall be equipped with a network port and shall have a network type data transfer interface with the DDC controller. The following interface shall be required:
   1. BACnet protocol compatible with the Owner furnished DDC system.
   2. The following analog signals shall be read to the DDC controller as a minimum: Space temperature.

E. Electrical: Furnish all starters, contactors and disconnects. Arrange for single point electrical connections. Provide power and control wiring.

F. Controls: Provide wall-mounted thermostat, fan on-auto switch, system off-auto switch, and individual set point for cooling with backlit LCD display. Hand-held remote controller is not acceptable.

PART 3 - EXECUTION

3.1 SPLIT-SYSTEM AIR CONDITIONING UNIT

A. Installation:
   1. Install in location shown on the Drawings. Level unit and secure to structure.
   2. Make piping connections and unit installation per manufacturer's recommendations and installation guides.
   3. Size and run refrigerant piping between fan coil unit(s) and air-cooled condensing unit(s) per manufacturer's recommendations. Provide traps and double suction and/or discharge risers if recommended by the manufacturer.
   4. Insulate refrigerant piping as specified in 23 07 00.
   5. Pipe condensate pan to floor drain per manufacturers installation guide.
   6. Make refrigerant piping connections, install refrigeration accessories and charge system. Provide additional refrigerant as required for proper operation at design capacities.

B. Start-up:
   1. General: Comply with manufacturer’s instructions.
   2. Install filters before operating unit.
   3. Insure proper refrigerant and air flow before operating unit compressor.

C. Provide interconnecting power and control wiring, routed in conduit from the outdoor unit to the indoor unit, and control panel thermostat. Where unit provided requires separate power connections to the indoor and outdoor units, provide at no additional cost. This shall include branch circuit conduit, wiring, circuit breaker, terminations, etc. as required for complete system. Branch circuit serving indoor unit shall originate in same panelboard serving outdoor unit.

D. Testing and Adjusting/Performance Test: Except where initial unit operation clearly shows the performance meets or exceeds the requirements, test to show compliance.

END OF SECTION

CONVECTION HEATING AND COOLING UNITS

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 provisions of Section 23 05 00, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:
   1. Heating/Cooling Coils, Water.
   2. Fan Coil Units.

1.3 SUBMITTALS

A. Submit the following:
   1. Catalog data showing dimensions and performance.
   2. Computer calculations for coil performance.
   3. Operation and Maintenance Data: Fan coil units.

PART 2 - PRODUCTS

2.1 HEATING/COOLING COILS, WATER

A. Acceptable Manufacturers:
   1. Aaon, USA Coil, Trane, Daikin-McQuay, JCI-York, Heatcraft, Greenheck, CES Group.
   2. Other Manufacturers: Submit Substitution Request.

B. Description:
   1. Coils of nonferrous extended surface construction with continuous 16 gauge galvanized steel casing for installation in air supply unit or ductwork as shown on Drawings.
   2. Primary surface of seamless copper tubing rolled into headers with copper bushings or brazed into nonferrous headers.
   3. Fins shall be nonferrous, mechanically bonded to tubes, with fin spacing of12 fins per inch maximum.
   4. Coils tested at 300 psi hydrostatic pressure, guaranteed for 250 psi working pressure.
   5. Arranged for serpentine flow in continuous circuits with counterflow between air and water without turbulating means; provide air vents at each coil.
   6. Supply and return connections on same side, with supply on bottom, downstream of air flow.
   7. 0.008-inch minimum fin thickness; 0.024-inch minimum tube wall thickness; 0.035-inch straight stock for U-turns.
   8. Capacity certified in accordance with ARI Standard 410-72. Face velocity not to exceed 500 fpm at specified air flow, or as scheduled.

2.2 FAN COIL UNIT

A. Acceptable Manufacturers:
   1. JCI as scheduled, Carrier, Trane, Daikin-McQuay, International, Air Therm.
   2. Other Manufacturers: Submit Substitution Request.

B. Description: Furnish complete unit including cabinet, fan and motor assembly, heating/cooling coil (designed for two-pipe changeover service) and filter. Unit U.L. approved for application and wired per NEC.

C. Cabinet: 18 gauge steel, welded and bolted construction, removable panels for access to components. Interior portions of cabinet insulated to prevent condensation. Factory applied baked enamel finish.

D. Fans and Motor: Steel construction designed for minimum noise levels, direct drive type, EC motor, fan controls.

E. Filters: Throwaway type, 2-inch thick fiberglass.

F. Water Coils: 3/4-inch OD seamless copper tubes, aluminum fins and end supports. Coil and heater construction shall be for 250 psi working pressure. Maximum 12 fins per inch.

G. Drain Pan: Galvanized steel drain pan with copper drain connection. Pan to extend under coil and coil connection for proper drainage of condensate.

H. Configuration: Vertical unit, bottom inlet, top outlet.

I. Controls: Configure unit for field installation of DDC control panel and sensors as follows:
   1. Valves, actuators and space temperature sensor will be furnished by Owner.

J. Electrical: Furnish magnetic contactors. Arrange for single point electrical connection. Provide all field wiring.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Heating/cooling Coils: Installed in air handling units as standard with manufacturer or in ductwork as shown.

B. Fan Coil Units:
   1. General: Install per manufacturer's instructions.
   2. Install owner-furnished valves and specialties as detailed on the Drawings.

C. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.

END OF SECTION

ELECTRICAL HEATING EQUIPMENT

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 provisions of Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Electric heat trace cable.

1.3 SUBMITTALS

A. Submit the following:
   1. Shop Drawings: Showing details of construction and dimensional data.
   2. Product Data: Showing performance data, ratings, electrical data, wiring diagrams, fusing quantity and types.
   3. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 HEAT TRACE CABLE

A. Acceptable Manufacturers:
   1. Chromalox, Raychem, Nelson.
   2. Other Manufacturers: Submit Substitution Request.

B. Cable: Self-regulating flat, flexible, low-heat density, parallel electric heater strip consisting of (2) stranded circuit conductors enclosed in a semi-conductive, polymer core insulated with a plastic jacket protected with a tinned-copper braid. Cable shall have capability of being overlapped without creating hot spots and shall be suitable for application on plastic, copper or steel pipe. Raychem XL-Trace, Chromalox SRF or approved equal.

C. Voltage: Cable shall operate on single phase line voltage of 208 VAC without transformation. Provide power connections, end seals, splices tap-offs and tees as furnished by the manufacturer.

D. Controls: System control for freeze protection shall include a thermostat with fixed setpoint of 40°F. Thermostat shall have a nickel-plated copper bulb at end of 36-inch capillary and shall be enclosed in a NEMA 4 enclosure. Raychem AMC-F5, Chromalox PIT or approved.

PART 3 - EXECUTION

3.1 HEAT TRACE CABLE

A. Location: Provide heat trace on all piping in unheated spaces as shown or required to prevent freezing.

B. Install heat trace cable on pipes indicated to maintain a minimum of 35°F in ambient temperature of 0°F. Lay cable parallel on pipe or spiral wrap to maintain adequate temperature as required by pipe size and thermal properties of the pipe insulation to be applied.

C. Attach heat trace cable to pipe with polyester tape at increments not exceeding 1'-0".

D. Install thermostat capillary and bulb to pipe with polyester tape assuring a firm bulb contact with pipe. Bulb shall not be in contact with heat cable.

E. Install thermostat at accessible location adjacent to pipe with a minimum of exposed capillary. Tape capillary to pipe run under insulation to bulb.

F. The installer shall be responsible for affixing an “Electric Traced” label to the outside of the pipe’s thermal insulation on alternating sides at intervals of five to fifteen feet immediately after the piping has been insulated.

G. Coordinate installation with work under Division 26 for adequate electrical service to each thermostat.

END OF SECTION

COMMON WORK RESULTS FOR ELECTRICAL

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 provisions of This Section, Common Work Results for Electrical, apply to all sections in Division 26.

C. All Sections of Division 26, ELECTRICAL, are interrelated. When interpreting any direction, material, and method specified in any section of Division 26, consider it within the entirety of Work in Division 26.

1.2 SUMMARY

A. The intent of Division 26 Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.

B. Include all work specified in Division 26 and indicated on Drawings, including appurtenances, connections, fasteners, and accessories required to make a complete working system, whether indicated or not indicated.

C. The Division 26 Specifications and the accompanying Drawings are complementary, and what is called for by one shall be as binding as if called for by both.
   1. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.
   2. In case of conflict, Specifications supersede Drawings.

D. Imperative language used in Division 26 Sections addresses the Contractor, as specified in Division 1 Section, “Summary”.

1.3 REFERENCES

A. The latest adopted revisions of the publications listed below apply to these Specifications as referenced:
   1. Oregon Structural Specialty Code. (OSSC)
   2. National Electrical Code (NEC).
   3. National Fire Protection Association (NFPA).
   4. National Electrical Manufacturers Association (NEMA).
   5. National Electrical Contractors Association (NECA).
   6. American National Standards Institute (ANSI).
   7. Institute of Electrical and Electronic Engineers (IEEE).
   8. Underwriters Laboratories (UL).
   9. Oregon Administrative Rules (OAR). The publications are referred to in the text by acronym or initials in parentheses above.

1.4 SYSTEM DESCRIPTION

A. Ground Systems:
   1. Provide complete ground systems indicated.
   2. Include conduit system, transformer housings, switchboard frame, and neutral bus, motors, and miscellaneous grounds required by Contract Documents and by applicable codes.

B. System Identification:
   1. Clearly identify all elements of the Project electrical system to indicate the loads served, or the function of each item of equipment, connected under this work.
   2. Comply with requirements of Division 26 Section, “Identification,” and with applicable codes.

C. Drawings:
   1. The Drawings are diagrammatic: they do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts with other construction.
      a. Prior to installing work, take field dimensions, and note conditions available for, installation.
      b. Follow the Drawings as closely as practical to do so, and install additional bends, offsets, and elbows where required by installation conditions.
         1) Additional offsets, bends, and other connectors are subject to approval by Project Engineer.
         2) Install additional offsets, bends, and other connectors without additional cost to Owner.
      c. The right to make any reasonable changes in outlet location prior to roughing in is reserved to the Owner's Representative.
   2. Luminaire Designations:
      a. Lower case letters adjacent to devices or luminaires indicate switching arrangement or circuit grouping.
      b. Numbers adjacent to devices indicate circuit connection.
   3. Circuits and Switching:
      a. Do not change branch circuiting and switching indicated; nor combine homeruns, without Engineer's prior approval.
      b. Do not combine or change feeder runs.
   4. Circuit Conductors:
      a. Cross or hash marks on conduit runs indicate quantity of No. 12 copper branch circuit conductors, unless otherwise noted.
      b. Where such marks do not appear, provide quantity of circuit conductors to the outlets shown to perform the control or circuiting indicated.
      c. Include ground, travelers and switchlegs required by the circuiting arrangement indicated.
      d. Provide a dedicated neutral conductor with each circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.

1.5 SUBMITTALS

A. Comply with Division 1, Section 01 33 00, Submittal Procedures".

B. Shop Drawings and Equipment Data:
   1. Combine electrical shop drawings and equipment data in Submittal binders.
   2. Include in Submittal binders:
      a. A complete index of materials and equipment required by Specifications to be documented by submittals.
      b. Manufacturer's detailed specifications and data sheets to fully describe equipment furnished.
      c. All deviations from the Drawings and Specifications, noted on the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.
      d. Electrical distribution equipment: Provide ¼ scale drawing with dimensions of the proposed electrical equipment for review and approval prior to ordering and installation of equipment, rough-ins and conduit installation.

C. Installation Drawings:
   1. Submit prior to starting installation.
   2. Show all outlets, devices, terminal cabinets, conduits, wiring, and connections required for the complete system described.

D. Submittals Procedures:
   1. Review and recommendations by the Architect or Engineer are not to be construed as change authorizations.

E. If discrepancies are discovered between the materials or equipment submitted, and the Contract Documents, either prior to or after the data is processed, the Contract Documents govern.

1.6 SUBSTITUTION REQUESTS

A. Comply with Division 1, Section 01 60 00, “Product Requirements”.

1.7 RECORD DRAWINGS:

A. Comply with Division 1, Section 01 78 39, “Project Record Documents”.

B. Keep record drawings up to date as the work progresses.

C. Show all changes, deviations, addendum items, change orders, corrections, and other variations from the Contract Drawings.

D. Keep record drawings at the jobsite and available for the Architect’s review.

E. At the completion of the work, incorporate all deviations from the installation drawings to indicate “as-built” conditions.

1.8 OPERATION AND MAINTENANCE DATA:

A. Comply with Division 1, Section 01 78 23, “Operation and Maintenance Data”.

B. Provide a separate manual or chapter for each system as follows:
1. Low voltage distribution system.
2. Emergency power system.
3. Standby power system.
4. Fire alarm system.
5. Lighting system.
6. Lighting control system.
7. Power metering and monitoring system.

C. Description of system.

D. Operating Sequence and Procedures:
1. Step-by-step procedure for system start-up, including a pre-start checklist.
    a. Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
2. Detailed instruction in proper sequence, for each mode of operation (i.e., day-night, staging of equipment).
3. Emergency Operation:
    a. If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under those conditions.
    b. Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components or other unusual condition.
4. Shutdown Procedure:
    a. Include instructions for stopping and securing the equipment after operation.
    b. If a particular sequence is required, give step-by-step instructions in that order.

E. Preventive Maintenance:
1. Schedule for preventive maintenance.
    a. State the recommended frequency of performance of each preventive maintenance task such as cleaning, inspection, and scheduled overhauls.
2. Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
3. Inspection: If periodic inspection of equipment is required for operation, cleaning, or other reasons, indicate the items to be inspected and give the inspection criteria.
4. Provide instructions for lubrication and adjustments required for preventive maintenance routines. Identify test points and given values for each.

F. Manufacturers' Brochures:
   1. Include manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views, and renewal parts lists.
   2. Edit manufacturers' standard brochures so that the information applying to the actual installed equipment is clearly defined.

G. Results of performance testing, as specified in Part 3 of This Section.

1.9 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All products and equipments shall comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipments within this specification contain these banned substances, provide complying products and equipments from approved manufacturers with equal performance characteristics.
   2. Provide work and materials conforming to:
      a. Local and State codes
      b. Federal and State laws and regulations.
      c. Other applicable laws and regulations.
   3. Obtain and pay for all permits, licenses, and inspection certificates required by authorities having jurisdiction.
   4. Pay any other fees required by governing authorities for work of this Division.

B. Install only electrical products listed by a recognized testing laboratory, or approved in writing by the local inspection authority as required by governing codes and ordinances.

1.10 SITE VISITATION

A. The Contractor shall visit the site prior to bidding and become familiar with existing conditions and all other factors which may affect the execution of the work. Coordination of installation of equipment with prior bid packages previously issued shall be completed. Include all related costs in the initial bid proposal.

1.11 COORDINATION

A. Coordinate Work of This Division with all other trades to ensure proper installation of electrical equipment.
   1. Review Drawings of other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, and other possible impediments to electrical work.
   2. Report potential conflicts to Architect prior to rough-in.
   3. Proceed with rough-in following Architect's directives to resolve conflicts.
   4. In general, the Architectural Drawings govern.

B. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor's responsibility includes:
   1. Coordination of the equipment to fit into the available space.
   2. Access routes through the construction.

C. Layout Drawings:
   1. Equipment arrangement shown on Drawings is diagrammatic to indicate general equipment sizing and spatial relationship. Contractor shall include, as part of distribution equipment submittal, a scaled floor plan which includes all equipment shown with their submitted sizes. Include all feeder conduit routing, both above-ground and underground, including termination points at equipment. Submit for Engineer's review prior to commencing work.
   2. Provide additional wiring details at switchboards, motor control centers, and other areas where work is of sufficient complexity to warrant additional detailing for coordination.
   3. Submit layout drawings for approval prior to commencing field installation.

D. Where electrical connections are required for equipment provided as Work of other Divisions, coordinate rough-in and wiring requirements for that equipment with its supplier and installer prior to commencing work. Notify Architect and Engineer of any discrepancies between the actual rough-in and wiring requirements, and those identified on Drawings for resolution prior to installation.

E. Arrange raceways, wiring, and equipment to permit ready access to switches, motors, and control components.
   1. Doors and access panels shall be kept clear.

F. Coordinate electrical utility service with the local serving utility.
   1. Contractor to include all costs associated with installation and connection of new electrical service to building.
   2. It shall be the Contractor's responsibility for contacting the local utility company (EWEB) to obtain utility design drawings specific to this project, and for scheduling utility company inspections in conformance with the project schedule. Utility infrastructure shall be installed as described on EWEB design documents. Installation based on electrical plans that vary from the EWEB design documents shall be corrected by the Contractor at no additional cost. Contact EWEB service planning, or Debbie Jenkins (541)685-7117.

G. Underground installation and project phasing: Underground Documents (Package 1) and Building/Site Documents (Package 2)
   1. Coordinate with approved underground Package 1 permit documents for installations below grade or in building concrete slab.
   2. Contractor shall review Package 2 requirements in order to plan for underground conduit routing and installation where required to comply with the requirements of the contract documents. Above-ground conduit shall be allowed where concealed or as otherwise noted. Installations requiring underground to remain concealed – including but not necessarily limited to devices in islands, CMU walls, below windows, and located at exterior – shall be planned accordingly and incorporated into Package 1 construction.

H. Coordinate underground work with other contractors working on the site.
   1. Coordinate particularly with contractors installing storm sewer, sanitary sewer, water, and irrigation lines to avoid conflicts.
   2. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.

1.12 CHANGE ORDERS

A. All supplemental cost proposals by the Contractor shall be accompanied with a complete itemized breakdown of labor and materials. At the Architect's request, Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor shall be separated and allocated for each item of work.

1.13 WARRANTY

A. Provide a written warranty covering the work of this Division as required by the General Conditions.

B. Apparatus:
   1. Free of defects of material and workmanship and in accord with the Contract Documents.
   2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.
   3. Operate at full capacity without objectionable noise or vibration.

C. Include in Contractor's warranty for Work of Division 26 system damage caused by failures of any system component.

1.14 ALTERNATES

A. Comply with Division 1 Section, “Alternates”.

B. Refer to Electrical Drawings for detailed information relating to the appropriate alternates.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where specified materials or methods conflict with applicable codes, the more stringent requirement applies.

B. Provide apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

C. Ensure that entire electrical system operates at full capacity without objectionable noise or vibration.

D. Materials and Equipment:
   1. Use materials and equipment that are:
      a. New.
      b. Of quality meeting or exceeding specified standards.
      c. Free of faults and defects.
      d. Conforming to Contract Documents.
      e. Of size, make, type, and quality specified.
      f. Suitable for the installation indicated.
      g. Manufactured in accordance with NEMA, ANSI, U.L. or other applicable standards.
      h. Otherwise as specified in Division 1 Section, “Product Requirements”.
   2. Equipment not meeting all requirements will not be acceptable, even though specified by name.
   3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer.
      a. Component parts of the entire system need not be products of same manufacturer.
   4. Basis of Design:
      a. Equipment scheduled or specified by performance or model number shall be considered the Basis of Design.
      b. If other equipment is provided in lieu of the Basis of Design equipment, assume responsibility for all changes and costs which may be necessary to accommodate this equipment, including, but not limited to:
         1) Different sizes and locations for connections.
         2) Different dimensions.
         3) Different access requirements.
         4) Any other differences.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Provide a complete properly operating system for each item of equipment specified.
   2. Install materials in a neat and professional manner.
   3. Comply with equipment manufacturer’s written instructions, the best industry practices, and the Contract Documents.
   4. Comply with latest published NECA Standard of Installation, and provide competent supervision.

B. Clarification:
   1. Where there is a conflict among manufacturer’s instruction, best practice, and the Documents, request clarification from the Architect prior to rough-in.

2. Architect's decision will be final.
3. Work installed without clarification shall be removed and corrected by the Contractor at no cost to the Owner.

3.2 INSTALLATION IN RATED CONSTRUCTION

A. Install intumescent material around ducts, conduits, and other electrical elements penetrating rated construction.

B. Comply with firestop materials manufacturer's written instructions to prevent spread of smoke or fire through sleeves or block-outs penetrating rated fire barriers.

C. Provide firestop materials specified in Division 7 Section, "Through-Penetration Firestop Systems," and as follows:
   1. Capable of passing a 3-hour test per ASTM E-814 (UL 1479).
   2. Consisting of material capable of expanding nominally eight times when exposed to temperatures of 250-350°F.
   3. An alternate method utilizing intumescent materials in caulk or putty complying with Division 7 Section, "Through-Penetration Firestop Systems" may be used.

3.3 EXCAVATION AND BACKFILL

A. Perform all necessary excavation and backfill for the installation of electrical work in compliance with Division 31.

B. For direct burial cable or non-metallic conduit, a minimum 3-inch cover of sand or clean earth fill shall be placed all around the cable or conduit on a leveled trench bottom. Lay all steel conduit on a smooth level trench bottom, so that contact is made for its entire length. Water shall be removed from trench while electrical conduit is being laid.

C. Place backfill in layers not exceeding 8-inches deep and compact to 95% of maximum density at optimum moisture to preclude settlement.
   1. Interior: Bank sand or pea gravel.
   2. Exterior: Excavated material with final 8-inches clean soil.

D. Following backfilling, grade all trenches to the level of surrounding soil. All excess soil shall be disposed of at the site as directed.

E. Provide 6-inches wide vinyl tape marked "ELECTRICAL" in backfill, 12-inches below finished grade, above all high voltage cable or conduit runs.

F. Coordinate patching of all asphalt or concrete surfaces disturbed by this work with General Contractor.

3.4 NOISE CONTROL

A. Minimize transmission of noise between occupied spaces.

B. Outlet Boxes:
   1. Do not install outlet boxes on opposite sides of partitions back to back.
   2. Do not use straight through outlet boxes, except where indicated.

C. Conduit:
   1. Route conduit along corridors or other "noncritical" space to minimize penetrations through sound rated walls, or through non-sound-rated partitions between occupied spaces.
   2. Grout solid and airtight all penetrations through sound rated partitions.
   3. Use flexible connections or attachments between independent wall structures.
      a. Do not rigidly connect (i.e., bridge) independent wall structures.

D. Do not install contactors, transformers, starters, and similar noise-producing devices on walls that are common to occupied spaces, unless otherwise indicated.
   1. Where such devices are indicated to be mounted on walls common to occupied spaces, use shock mounts, or otherwise isolate them to prevent the transmission of noise to the occupied spaces.

E. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

3.5 EQUIPMENT CONNECTIONS

A. General:
   1. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices, and labor necessary for a finished working installation.
   2. Verify the location and method for connecting to each item of equipment prior to roughing-in.
   3. Check the amperage, maximum overcurrent protection, voltage, phase and similar attributes of each item of equipment before rough-in and connection.

B. Motor Connections:
   1. Make motor connections for the proper direction of rotation.
   2. Minimum Size Flex for Mechanical Equipment: 1/2-inch; except at small control devices where 3/8-inch flex may be used.
   3. Exposed Motor Wiring: Jacketed metallic flex with minimum 6-inches slack loop.
   4. Do not test run pump motors until liquid is in the system.

C. Control devices and wiring relating to the HVAC systems are furnished and installed under Division 23; except for provisions or items indicated in Division 26 Drawings and Specifications.

3.6 EQUIPMENT SUPPORT

A. Minimum Support Capacity:
   1. Provide fastening devices and supports for electrical equipment, luminaires, panels, outlets, and cabinets capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure.

B. Luminaire Supports:
   1. Support luminaires from the building structure.
   2. Use supports that provide proper alignment and leveling of luminaires.
   3. Where permitted at exposed luminaires, install flexible connections neat and straight, without excess slack, and attached to the support device.

C. Support all junction boxes, pull boxes, or other conduit terminating housings located above the suspended ceiling from the floor above, roof, or penthouse floor structure to prevent sagging or swaying.

D. Conduits:
   1. Support suspended conduits 1-inch and larger from the overhead structural system with metal ring or trapeze hangers and threaded steel rod having a safety factor of four.
   2. Conduits smaller than 1-inch installed in ceiling cavities, may be supported on the mechanical system supports when available space and support capacity has been coordinated with the subcontractor installing the supports.
   3. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.

E. Powder actuated or similar shot-in fastening devices will not be permitted for any electrical work except by special permission from the Architect.

3.7 ACCESS DOORS

A. Furnishing and installation of access doors is work of Division 8 Section 083100, “Access Doors and Frames”.

3.8 ALIGNMENT

A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines.

B. Install distribution equipment and all electrical enclosures fitted neatly, without gaps, openings, or distortion.

C. Properly and neatly close all unused openings with approved devices.

D. Fit surface panels, devices, and outlets with neat, appropriate, trims, plates, or covers without overhanging edges, protruding corners, or raw edges.

3.9 CUTTING AND PATCHING

A. General:
   1. Comply with Division 1 Section, “Cutting and Patching”.
   2. Restore to original condition new or existing work cut or damaged by installation, testing, and removal of electrical Work.
   3. Patch and finish spaces around conduits passing through floors and walls to match the adjacent construction, including painting or other finishes.
   4. Clean up and remove all dirt and debris.

B. Make additional required openings by drilling or cutting. Use of jackhammer is prohibited.

C. Fill holes that are cut oversize so that a tight fit is obtained around the objects passing through.
   1. In rated construction, comply with Division 7 Section, “Through-Penetration Firestop Systems”.

D. Obtain Architect’s permission and direction prior to piercing beams or columns.

E. Where alterations disturb lawns, paving, walks, and other permanent site improvements, repair and refinish surfaces to condition existing prior to commencement of work.

3.10 PROTECTION OF WORK

A. Protect all electrical work and equipment installed under this Division against damage by other trades, weather conditions, or any other causes.
   1. Equipment found damaged or in other than new condition will be rejected as defective.

B. Keep switchgear, transformers, panels, luminaires, and all electrical equipment covered or closed to exclude dust, dirt, and splashes of plaster, cement, paint, or other construction material spray.
   1. Equipment not free of all such contamination is not acceptable.

C. Provide enclosures and trims in new condition, free of rust, scratches, and other finish defects.
   1. If damaged, properly refinish in a manner acceptable to the Architect.

3.11 COMPLETION AND TESTING

A. General:
   1. Comply with Division 1 Section, “Quality Requirements”.

B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults and unintentional grounds.
   1. Schedule system tests so that several occur on the same day.
   2. Coordinate testing schedule with construction phasing.
   3. Conduct tests in the presence of the Architect or its representative.
   4. Notify Architect of tests 48 hours in advance.

C. Engage a journeyman electrician with required tools to conduct equipment tests. Arrange to have the equipment factory representative present for those test where the manufacturer's warranty could be impacted by the absence of a factory representative.

D. Perform tests per the requirements of each of the following systems:
   1. Low voltage distribution system.
   2. Emergency power system.
   3. Standby power system.
   4. Fire alarm system.
   5. Lighting system.
   6. Lighting control system.
   7. Power metering and monitoring system.

E. Provide a written record of performance tests and submit with operation and maintenance data.

3.12 COMMISSIONING

A. Complete all phases of work so the system, equipment, and components can be checked out, started, calibrated, operationally tested, adjusted, balanced, functionally tested, and otherwise commissioned. Complete systems, including all subsystems, so they are fully functional.

B. Perform commissioning as specified in Section 01 91 00, General Commissioning Requirements, the technical sections, and Section 26 08 00, Commissioning of Electrical Systems.
   1. Unless specified otherwise in the technical sections, provide factory startup services for the following items of equipment:
      a. Transformers.
      b. Primary switchgear.
      c. Secondary switchgear.
      d. Emergency power systems.
      e. Electrical distribution systems.
      f. Lighting control systems.

C. Participation in Commissioning:
   1. Provide skilled technicians to checkout, startup, calibrate, and test systems, equipment, and components.
   2. The Engineer reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system.

D. Resolution of Deficiencies:
   1. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process. Experimentation to render system performance will be permitted.

E. Verification and Documentation:
   1. As each test is performed, the Contractor shall have the commissioning manager observe the physical responses of the system and compare them to the specified requirements to verify the test results.
   2. Submit site observation reports for deficiencies in the system.
   3. Record the result of individual checks or tests on the pre-approved checklist, test, and report form from the commissioning plan and submit results for review.

END OF SECTION

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 1 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section, Common Work Results for Electrical apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Copper conductors. Indicated sizes shall be considered minimum for ampacities and voltage drop requirements.
   2. Conductors for special systems shall be as recommended by the equipment manufacturer except as noted.
   3. Deliver conductors to the job site in cartons, protective covers, or on reels.

B. Related Sections include:
   1. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   2. Section 26 05 33 Raceways and Boxes for Electrical Systems.
   3. Section 26 05 53 Identification for Electrical Systems.
   4. Section 26 05 80 Electrical Testing.

1.3 REFERENCED STANDARDS

A. ASTM: American Society For Testing and Materials:
   1. ASTM B 3 – Soft or Annealed Copper Wire.
   2. ASTM B 8 – Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. ASTM B 33 – Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. ICEA: Insulated Cable Engineers Association:
   1. S-95-658 – Non-shielded 0-2 kV Cables

C. IEEE: Institute of Electrical and Electronic Engineers:
   1. IEEE 383 – Type Test of Class IE Electric Cables, Field Splices, and Connections.

D. UL: Underwriters Laboratories:
   1. UL 44 – Rubber-Insulated Wires and Cables.
   2. UL 83 – Thermoplastic-Insulated Wires and Cables.
   3. UL 1277 – Type TC Power and Control Tray Cable.

1.4 SUBMITTALS

A. Submit product data for the following materials:
   1. Single conductor 600-volt power and control conductors.
   2. MC cable.

B. Submittals of the following materials shall consist only of a listing of the manufacturer’s name and the applicable catalog numbers of the items to be utilized.
   1. Connectors.
   2. Branch circuit conductor splices.
   3. Splices with compression fitting and heat-shrinkable insulator.

C. Submit cable test data per testing requirements of Part 3.

PART 2 - PRODUCTS

2.1 CONDUCTORS – 600V

A. Type:
   1. Copper: No. 12 AWG minimum size unless noted otherwise. No. 12 and No. 10, stranded, No. 8 or larger, Class B concentric or compressed stranded.
   2. Aluminum is not permitted and shall not be utilized.

B. Insulation:
   1. THHN/THWN-2 for conductors 6 AWG and smaller.
   2. XHHW-2 for conductors 4 AWG and larger.

C. Thru wiring in fluorescent luminaires shall be rated for 90 degree C minimum.

D. Manufacturers: General, Essex, Southwire, or equivalent.

2.2 POWER LIMITED WIRING

A. Copper, stranded or solid as recommended by the system manufacturer.

B. Insulation shall be appropriate for the system and location used.

2.3 MC CABLE

A. Sheath: Steel, of the interlocking metal type, continuous and close fitting. The sheath shall not be considered a current carrying or grounding conductor.

B. Conductors: Solid copper, of the same ampacity as the conduit/wire system indicated for the specific location. Provide separate green insulated grounding conductors in circuits where an isolated ground is called for.

2.4 CONNECTORS – 600V AND BELOW

A. Branch Circuit Conductor Splices:
   1. Live spring type, Scotchlok, Ideal Wire Nut, Buchanan B-Cap, or 3M Series 560 self-stripping type.

B. Cable Splices: Compression tool applied sleeves, Kearney, Burndy, or equivalent with 600V heat shrink insulation. Except where specifically indicated on the plans, all proposed splice locations shall be submitted for review by the Engineer.

C. Terminator Lugs for Stranded Wire:
   1. 10 AWG Wire and Smaller: Spade flared, tool applied.
   2. 8 AWG Wire and Larger: Compression tool applied, Burndy, Anderson, or equivalent.
   3. Setscrew type terminator lugs furnished as an integral part of switches and circuit breakers will be acceptable.

PART 3 - EXECUTION

3.1 CONDUCTORS

A. Pulling compounds may be used for pulling all conductors. Clean residue from the conductors and raceway entrances after the pull is made.

B. Pulleys or blocks shall be used for alignment of the conductors when pulling. Pulling shall be in accordance with manufacturer’s specifications regarding pulling tensions, bending radii of the cable, and compounds.

C. Make up and insulate wiring promptly after installation of conductors. Wire shall not be pulled in until all bushings are installed and raceways terminations are completed. Wire shall not be pulled into conduit embedded in concrete until after the concrete is poured and forms are stripped.

D. Provide a dedicated neutral conductor with each branch circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.

3.2 MC CABLE

A. MC cable is allowed only for lighting fixture whips, maximum 6-ft length.

B. MC cable shall not be used for branch circuit homeruns to branch panelboards. EMT or RMC conduit shall be utilized for all branch circuit homeruns to branch panelboards.

C. MC cable routing shall be coordinated with other trades and kept clear of and utilities to avoid exposure to damage. MC cable shall be properly supported per NEC Article 330 requirements.

3.3 CONNECTORS

A. Control and special systems wires shall be terminated with a tool applied spade flared lug when terminating at a screw connection.

B. All screw and bolt type connectors shall be made up tight and retightened after an eight hour period.

C. All tool applied compression connectors shall be applied per manufacturer's recommendations and physically checked for tightness.

3.4 COLOR CODING

A. Secondary service, feeders, and branch circuit conductors shall be color coded. Phase color code to be consistent at all feeder terminations, A-B-C left-to-right, A-B-C top-to-bottom, or A-B-C front-to-back. Color code shall be as follows:

120/240 volt 208Y/120 volt	**Phase**	**480 volt 480Y/277 volt**
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray*
Green	Ground**	Green
* or white with colored (other than green) tracer **Ground for isolated ground receptacles shall be green with yellow tracer.		

B. Use solid color compound or solid color coating for No. 12 and No. 10 branch circuit conductors and neutral sizes.

C. Phase conductors No. 8 and larger color code using one of the following:
   1. Solid color compound or solid color coating.
   2. Stripes, bands, or hash marks of color specified above.
   3. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

D. Switchlegs, travelers, etc., to be consistent with the phases to which connected or a color distinctive from that listed.

E. Color-coding of the flexible wiring system conductors and connectors shall be the manufacturer's standard.

F. For modifications and additions to existing wiring systems, color-coding shall conform to the existing wiring system.

3.5 FIELD TESTING

A. All 600-volt rated conductors shall be tested by the Contractor for continuity. Conductors 100A and over in size shall be meggered after installation and prior to termination. Provide the megger, rated 1,000 volts d.c., and record and maintain the results, in tabular form, clearly identifying each conductor being tested.
   1. Replace cables when test value is less than 15 megohms.
   2. Cable test submittal shall include results, equipment used, and date.

END OF SECTION

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 1 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Provide complete ground systems as indicated. Include conduit system, transformer housings, switchboard frame and neutral bus, motors, and miscellaneous grounds required.
   2. Provide 600 volt insulated main bonding jumper for utility company connection between ground bus in switchgear lineup and ground termination point or service ground in transformer vault as directed by the utility.
   3. Provide an insulated ground conductor in every conduit or raceway containing power conductors.
   4. Continue existing system as specified herein and shown on the Drawings.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 33 Raceways and Boxes for Electrical Systems.
   3. Section 26 05 80 Electrical Testing.
   4. Section 26 22 00 Low Voltage Transformers.
   5. Section 26 24 13 Switchboards.
   6. Section 26 24 16 Panelboards.
   7. Section 26 27 26 Wiring Devices.
   8. Section 26 29 00 Motor Controllers.

PART 2 - PRODUCTS

2.1 GROUND CONDUCTORS

A. Green insulated copper for use in conduits, raceways, and enclosures.

B. Bare copper for ground grids and grounding electrode systems.

2.2 CONNECTORS

A. Cast, set screw or bolted type.

B. Form poured, exothermic welds.

C. Grounding lugs where provided as standard manufacturer’s items on equipment.

2.3 GROUND PADS

A. Provide a ground pad at each location shown on the Drawings. Pad shall be 1000A rated copper bus nominally 1/4"x4"x12" long or as shown on the plans.

B. Provide 1/4-inch and 1/2-inch bolt holes per ANSI TIA/EIA 607 standards for telecom ground bars.

C. Mount ground pads with stand-off devices to provide a minimum of 1-1/2 inches free space behind pad for access to lug nuts and washers.

2.4 GROUND RODS

A. Copperclad steel, 5/8"x10'-0" long ground rods. Where ground wells are indicated, provide a 12-inch deep, 8-inch diameter precast concrete well with flush lid for accessibility and inspection of welded connections, RCP Vaults No. 12R12A with 12R12-t cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grounding Conductors: Sized in accordance with Article 250, Tables 250.66 and 250.122 of the National Electrical Code.

B. Grounding Conductor Connectors: Made up tight and located for future servicing and to insure low impedance.

C. Ground the electrical system, the cold-water service, structural steel, and transformers to the building ground grid.

D. All Plug-in Receptacles: Bonded to the boxes, raceways, and grounding conductor.

3.2 UFER GROUND

A. Provide a concrete encased building grounding electrode where shown on the Drawings. Grounding electrode shall consist of a minimum of 20 feet of No. 4/0 bare copper conductor cast into the bottom 6 inches of an exterior concrete foundation or footing.

3.3 EQUIPMENT

A. Provide separate green insulated equipment ground conductor in all non-metallic and flexible electrical raceways. Effectively ground all luminaires, panels, controls, motors, disconnect switches, exterior lighting standards, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, buses, etc., for this purpose.

B. Provide grounding bushings on all feeder conduit entrances to panels and equipment enclosures and bond bushings to enclosures with minimum 10 AWG conductor. Connect the equipment ground to the building system ground. Use the same size equipment ground conductors as phase conductors, up through 10 AWG.

3.4 GROUND PADS

A. Drill ground pads as necessary for attachment of all grounding conductors as required.

B. Utilize 2-hole lugs for terminating 4/0 AWG and larger ground conductors.

C. Bond ground pads to adjacent structural steel with #4/0 bare copper cable, using form poured exothermic welds.

3.5 GROUND RESISTANCE TEST

A. Ground electrode resistance test shall be accomplished with a ground resistance direct-reading single test meter utilizing the Fall-of-Potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the concrete-encased ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.

B. Test results shall be in writing and shall show temperature, humidity, and condition of the soil at the time of the tests. In the case where the ground resistance exceeds 5 ohms the Engineer will issue additional instructions.

END OF SECTION

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 1 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This section describes supporting devices for electrical equipment, associated conduit, and cable.

B. Related Sections include:
   1. Section 26 05 33 Raceways and Boxes for Electrical Systems.
   2. Section 26 05 36 Cable Trays for Electrical Systems.
   3. Section 26 22 00 Low Voltage Transformers.
   4. Section 26 24 13 Switchboards.
   5. Section 26 24 16 Panelboards.
   6. Section 26 50 00 Lighting.

1.3 REFERENCED STANDARDS

A. International Building Code (IBC)

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Hangers: Kindorf B-905-2A channel, H-119-D washer, C105 strap, minimum 1/2-inch rod with ceiling flange, or equal.

B. Pipe Straps: Two-hole galvanized or malleable iron.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide all electrical equipment supports.

B. Install vertical support members for equipment, straight and parallel to building walls.

C. Provide independent supports to structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over furred or suspended ceilings.

D. Do not use other trades' fastening devices to support electrical equipment materials or fixtures.

E. Do not use supports and/or fastening devices to support other than one particular item.

F. Support conduits within 18 inches of outlets, boxes, panels, cabinets, and deflections.

G. Provide complete seismic anchorage and bracing for the vertical and lateral restraint of conduit, cable trays, bus ducts, and electrical equipment as required by IBC Chapter 16 and the most recent version of the SMACNA Seismic Restraint Manual for Seismic Hazard Level (SHL) A. Shop drawings of bracing systems shall be submitted to the Architect for review and shall bear the seal of a professional engineer registered in the State of Oregon.

3.2 LUMINAIRES

A. Light-Duty Ceiling Systems:
   1. Attach No. 12 hanger wire from each corner of the luminaire to the structure above.
   2. Positively and securely attach luminaire within 6 inches of each corner to the suspended ceiling framing member by mechanical means.

B. Intermediate-Duty Ceiling Systems:
   1. Positively and securely attach luminaire within 6 inches of each corner to the suspended ceiling framing member by mechanical means.
   2. Attach No. 12 hanger wire within 3 inches of each corner of each luminaire.
   3. Connect two 12-gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.
   4. Support luminaries weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

C. Heavy-Duty Ceiling Systems:
   1. Positively and securely attach luminaire within 6 inches of each corner to the suspended ceiling framing member by mechanical means.
   2. Connect two 12-gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.
   3. Support luminaries weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

3.3 PULL AND JUNCTION BOXES

A. Pull and junction boxes installed within the cavity of a suspended ceiling that is not a fire rated assembly may be attached to the suspended ceiling framing members, provided the following criteria are met:
   1. Installation complies with the ceiling system manufacturer's instructions.
   2. Pull or junction box is not larger than 100 cubic inches.
   3. The pull or junction box is supported to the main runner with two fastening devices that are designed for framing member application and positively attach or lock to the member.
   4. The pull or junction box serves branch circuits and associated equipment in the area.
   5. The pull or junction box is within 6 feet of the luminaires supplied.
   6. The framing members are not rotated more than 2 degrees after installation.
   7. Pull and junction boxes installed within the cavity of a suspended ceiling may be attached to independent support wires, provided the following criteria are met:
      a. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
      b. Pull or junction box is not larger than 100 cubic inches.
      c. The pull or junction box is secured to the independent support wires by two fastening devices that are designed for the application.
      d. Independent support wires in a fire-rated ceiling are distinguishable by color, tagging or other effective means.

3.4 CABLES AND RACEWAY

A. Cables and raceway installed within the cavity of a suspended ceiling may be attached to independent support wires provided the following criteria are met:
   1. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
   2. Raceways are not larger than one inch trade size and cables and bundled cables are not larger than one inch diameter including insulation.
   3. Not more than three raceways or cables are supported by any independent support wire and are supported within the top or bottom 12 inches.
   4. Cables for Class 2 power-limited signaling systems and other power limited systems are securely fastened within 2 feet of each termination and at intervals not to exceed 5 feet or per the manufacturer's installation instructions.
   5. Raceways are secured at intervals required for the type of raceway installed.

6. Cables and raceway are secured to independent support wires by fastening devices and clips designed for the purpose.
7. Independent support wires are distinguishable by color, tagging, or other effective means.

B. Cables and raceway installed within the cavity of a suspended ceiling may be supported with trapezes constructed of steel rods and channels provided the following criteria are met:
1. The size of the rods, channel, and fastening devices are suitable for the anticipated weight.
2. The spacing of the trapezes meets that required for the type of raceway installed.
3. Cables and raceway are secured to a trapeze by straps designed for the purpose.
4. Cables and raceway do not support other raceway or cables.
5. An appropriately sized seismic bracing system is installed.

END OF SECTION

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 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Raceways and conduits of specified types for all electrical system wiring, except where clearly indicated otherwise.
   2. All fittings, boxes, hangers, and appurtenances required for the conduits and raceways.
   3. Size raceways and conduits as indicated. Where no size is indicated, conduit may be the minimum code permitted size for the quantity of conductors installed, based upon NEC tables for conductors with type THW insulation.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   3. Section 26 05 29 Hangers and Supports for Electrical Systems.
   4. Section 26 05 53 Identification for Electrical Systems.

PART 2 - PRODUCTS

2.1 METALLIC CONDUITS

A. Rigid Metal Conduit (RMC): Smooth surfaced heavy wall mild steel tube of uniform thickness and temper, reamed and threaded at each end and protected inside and out with galvanizing, sherardizing, or equivalent process. RMC shall comply with NEC Article 344.

B. Intermediate Metallic Conduit (IMC): Smooth surface, intermediate wall mild steel tube of uniform thickness and temper, reamed and threaded at each end, and protected inside and out with galvanizing, sherardizing, or equivalent process. IMC shall comply with NEC Article 342.

C. Electrical Metallic Tubing (EMT): Smooth surface, thin wall mild steel tube of uniform thickness and temper, galvanized or sherardized on the outside, and enameled on the interior. EMT shall comply with NEC Article 358.

D. Flexible Conduits (Flex):
   1. Flexible Metallic Conduit: Interlocking single strip steel construction, galvanized inside and out after fabrication. Flex shall comply with NEC Article 348.
   2. Liquid Tight: Similar to flexible metallic conduit, except encased in a liquid tight polyvinylchloride or equivalent outer jacket over the flexible steel core, and shall comply with NEC Article 350.

2.2 NON-METALLIC CONDUITS

A. Rigid Non-Metallic Conduit: Type II PVC Schedule 40, suitable for use with 90°C rated wire. Conduit shall conform to UL Standard 65l and carry appropriate UL listing for above and below ground use.

B. Non-metallic tubing (ENT)
   1. ENT Raceway shall be blue polyvinyl chloride (PVC) branch wiring.
   2. ENT Raceway shall be available in trade sizes 1/2" through 2".
   3. ENT Raceway shall be easily cut to length using shear type cutters.
   4. ENT Raceway shall be hand bendable, corrugated of circular cross section. No special tools needed for bending.
   5. ENT Raceway, Fittings, Boxes and Accessories shall not rust.
   6. ENT shall provide protection for power wiring conductors.
   7. ENT shall have an ambient temperature range -4º F to 122º F.
   8. ENT shall meet requirements of NEC for Electrical Nonmetallic Tubing.
   9. Single manufacture shall provide ENT, Fittings, Boxes and Accessories to form a complete integrated raceway system.
   10. ENT shall be listed to the requirements of UL Standard UL 1653 in accordance with Article 362 of the NEC and Section 12-1500 of the CEC.
   11. ENT Raceway shall be recognized for use with PVC rigid nonmetallic conduit fittings.
   12. ENT Raceway shall be rated for 90°C conductors.
   13. Conductors shall easily push through the raceway (up to approximately 50 feet).
   14. ENT Raceway shall be available in sticks, coils and reels.

   B. Fittings
      1. Fittings used withed ENT shall be listed and/or certified.
      2. One piece ENT Coupling, Threaded Terminator and RNC Transition Fittings shall be rated concrete tight without tape.
      3. Vertical and 45º Stub Downs shall be made available in 1/2" through 1" trade sizes. (Molded part to retain ENT for concrete pour and provides clearance for attaching fittings to ENT).
      4. Vertical and 90º Stub Down Transition Adapter shall be made available in 1/2" through 1" trade sizes (Molded part to retain ENT for concrete pour and provides threaded port for transitioning to other conduit systems).
      5. Quick Connect Couplings shall be available in 1/2"-1" trade sizes (Molded part which allows two pieces of ENT to be quickly coupled).
      6. Quick Connect Male Threaded Adapter shall be available in 1/2"-1" trade sizes (Molded part which snaps onto a piece of ENT to allow it to have a male threaded end).
      7. Quick Connect Male Snap-in Adapters shall be available in 1/2"-1" trade sizes (Molded part which snaps onto a piece of ENT to allow it to connect to an outlet or switch box).
      8. Schedule 40 Male Terminal Adapter shall be available (Molded fitting which is solvent cemented to a piece of ENT to provide a male threaded end).
      9. Schedule 40 Nonmetallic Couplings shall be available (Molded part which allows two pieces of ENT to be connected together with solvent cement).
      10. Non-Metallic ENT Transition Adapters shall be available
         a. Male ENT to schedule 40 & 80 PVC Conduit
         b. ENT to EMT
         c. Reducers, ¾" to ½" ENT and 1" to ¾" ENT

2.3 WIREWAYS

A. Troughs: Steel, painted, square in cross section, preformed knock-outs on standard spacing, screw cover.

B. Fittings: Tees, elbows, couplings as required for configuration shown on the Drawings.

2.4 FITTINGS

A. RMC and IMC:
   1. Threaded Locknuts: Sealing type where used with NEMA 2, 3, 3R, 4 and 12 enclosures.
   2. Threaded Bushings: 1-1/4-inch and larger, insulated, grounding type as required under Section 26 05 26.
   3. Threaded Couplings: Standard threaded of the same material and as furnished with conduit supplied. Erickson type couplings may be used where required to complete conduit runs larger than 1 inch.

B. EMT:
   1. Connectors: Steel compression ring or steel set screw type for conduit termination, with insulated throat, suitable for conditions used. Use lay-in grounding type bushings where terminating grounding conductors.
   2. Couplings: Steel compression ring or steel set screw type, concrete tight.

C. Threadless: RMC and IMC couplings and box connectors may be steel threadless, compression ring or set screw type for use with conduits 1 inch and smaller where installed in poured concrete locations or where limited working space makes threaded fittings impractical.

D. Weatherproof Connectors: Threaded.

E. Expansion Couplings: Equivalent to O.Z. type EX with jumper.

F. Seal-Offs: With filler fiber, compound, and removable cover.

2.5 METALLIC BOXES

A. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears for device ring mounting, knock-out plugs, mounting holes, fixture studs if required, RACO or equivalent.

B. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings; cast steel or aluminum with threaded hubs or bosses for use on walls.

C. Large Boxes: Boxes exceeding 4-11/16 inches square when required shall be welded steel construction with screw cover and painted, steel gauge as required by physical size, Hoffman, Circle AW or equivalent.

D. Systems: Boxes for systems devices shall be as recommended by the systems manufacturer, suitable for the equipment installed. Equip with grounding lugs, brackets, device rings, etc., as required.

2.6 NON-METALLIC BOXES

A. Boxes used with ENT shall be listed and/or certified.

B. Non-metallic Mud Boxes shall be available.

C. Mud Boxes with two 1", four ½" and six ¾" ports shall be available

D. Mud Boxes with quick connect ports shall be molded out of Polycarbonate

E. Mud Boxes with removable back shall be available

F. Mud Box types shall include;
   1. Ceiling Box listed for fixture support up to 50 lbs. and ceiling fan support up to 35 lbs
   2. One Gang
   3. Two Gang
   4. 4 Square

G. Non-Metallic Outlet and Switch Box shall be available in Single and Two Gang
   1. Boxes shall have eccentric knockouts
   2. Two gang shall have dual voltage capability
   3. Optional dual voltage divider shall be available

H. Non-Metallic Box Extenders shall be available.

I. Non-Metallic Plaster Rings shall be available.

J. Non-Metallic Blank Covers shall be available.

K. Non-Metallic 4" Octagon Ceiling Boxes shall be available

2.7 FLOOR BOXES

A. Concealed power floor box with flush hinged door. Nominal 7 1/2" x 7 1/2"x 3" stamped steel concrete tight box with multiple conduit entrances and pre-pour adjusting screws.
   1. Gray cast aluminum door suitable for polished concrete.
   2. Hubbell S1SFB series or approved equal.

B. Combination concealed power and data floor box with flush hinged door. Nominal 7 ½" x 7 ½" x 3" stamped steel concrete tight box with multiple conduit entrances and pre-pour adjusting screws.
   1. Gray cast aluminum door suitable for polished concrete.
   2. Hubbell S1SFB series or approved equal.

C. PVC, molded enclosures, threaded hubs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conceal all conduits in finished spaces. Concealed conduits shall run in a direct line with long sweep bends and offsets. RMC and IMC embedded in concrete below grade or in damp locations shall be made watertight by painting the entire male thread with Rustoleum metal primer or equivalent before assembly.

B. Route exposed conduit parallel or at right angles to structural building lines and neatly offset into boxes. Conduits attached directly to building surfaces shall closely follow the surfaces. Conduit fittings shall be used to "saddle" under beams. Drilling or notching of existing beams, trusses on structural members shall be coordinated with Architect prior to commencing.

C. RMC and IMC terminations at boxes, cabinets, and general wiring enclosures shall be rigidly secured with double locknuts and bushings or approved fittings. Conduit shall be screwed in and shall engage at least five threads in hub where conduit boxes with threaded hubs or bosses are used. Insulating bushings shall be used for conduits 1-1/4-inches or larger.

D. Keep conduit and raceways closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete, or foreign objects. Raceways shall be clean and dry before installation of wire and at the time of acceptance.

E. Pack spaces around conduits with polyethylene backing rods and seal with polyurethane caulking to prevent entrance of moisture where conduits are installed in sleeves or block-outs penetrating moisture barriers.

F. Exposed Ceiling Structure Areas: For spaces/rooms which do not have a finished ceiling to conceal conduit installations, underground conduit shall be provided where practical. Above-ground conduits for such areas shall have routing planned in advance. Contractor shall provide a proposed conduit routing plan in advance for review and approval by the Architect prior to rough-in and installation. Above-ground conduits shall be routed and supported parallel and perpendicular to building lines and structure, and tight to structural elements where practical.

G. Plenum Installation: Conduit systems routing through plenum spaces shall meet code requirements for plenum installation and be suitable for such areas. Protect cabling in conduit where cabling is not suitable/listed for installation plenum spaces.

3.2 CONDUIT

A. RMC:
   1. RMC may be used in all areas for all wiring systems.
   2. RMC shall be installed where exposed at exterior locations and where otherwise subject to physical damage.
   3. RMC shall be installed with threaded fittings made up tight.

B. IMC:
   1. IMC may be used for all circuits rated 600V and less where not in contact with earth or fill.
   2. IMC shall be installed with threaded fittings made up tight.

C. EMT:
   1. EMT may be used in all other dry protected locations for circuits rated 600V and less.
   2. EMT, whether exposed or concealed, shall be securely supported and fastened at intervals of nominally every 8 feet and within 24 inches of each outlet, ell, fitting, panel, etc.

D. Flex:
   1. Flex shall be used for connections to vibration producing equipment (such as motors, transformers, and mechanical equipment) and where installation flexibility is required with a minimum 12 inches slack connection.
   2. Limit flex length to 36 inches for exposed equipment connections and 72 inches in concealed ceiling and wall cavities.
   3. PVC jacketed flex shall be used in wet locations, areas subject to washdown, and exterior locations.
   4. Flex shall not be used to circumvent a rigid raceway system as required by this specification.

E. PVC:
   1. Type II Schedule 40 and 80 PVC may be used underground and in and under interior slabs, poured concrete and CMU walls, and where scheduled or noted on the Drawings.
   2. Make connections with waterproof solvent cement.
   3. Provide RMC at 60 degree and larger bends and where penetrating slabs.

F. ENT:
   1. ENT may be used in walls and above non-plenum rated ceilings for lighting and power system drops within a room.
   2. ENT shall be securely fastened at proper intervals per NEC Article 362.
   3. ENT shall comply with conduit bending requirements listed in NEC Article 362.
   4. ENT shall not be used to circumvent a rigid raceway system as required by this specification.
   5. ENT shall not be installed where exposed to physical damage. Coordinate with other trades and route ENT clear of equipment and possible routes of service access.

3.3 RACEWAYS

A. Surface metal wireways may be installed at locations to serve motor starters or other control devices where required by a multitude of wiring interconnections or physical layout.

3.4 FITTINGS

A. Metallic raceways and conduits shall be assembled continuous and secured to boxes, panels, etc., with appropriate fittings to maintain electrical continuity. All conduit joints shall be cut square and reamed smooth with all fittings drawn up tight.

B. Crimp-on, tap-on, indenter type, malleable iron or cast set screw fittings shall not be used.

3.5 BOXES

A. General:
   1. Outlet boxes shall be of code required size to accommodate all wires, fittings, and devices.
   2. Provide multi-gang boxes as required to accept devices installed with no more than one device per gang.

3. Equip all metallic boxes with grounding provisions as described in NEC Article 250. Equipment Grounding Conductors routing through metallic boxes shall be grounded to the box using approved grounding connection means.

B. Size and Type:
1. Flush wall switch and receptacle outlets used with conduit systems shall be 4 inches square, 1-1/2 inches or more deep, with one or two-gang plaster ring, mounted vertically. Where three or more devices are at one location, use one piece multiple gang tile box or gang box with suitable device ring.
2. Wall bracket and ceiling surface mounted luminaire outlets shall be 4-inch octagon 1-1/2 inches deep with 3/8-inch fixture stud where required. Wall bracket outlets shall have single gang opening where required to accommodate luminaire canopy. Provide larger boxes or extension rings where quantity of wires installed requires more cubic capacity.
3. Junction boxes installed in accessible ceiling or wall cavities or exposed in utility areas shall be a minimum of 4 inches square, 1-1/2 inches deep with appropriately marked blank cover.
4. Boxes for the special systems shall be suitable for the equipment installed. Coordinate size and type with the system supplier.
5. Junction boxes for all power, lighting, and low-voltage systems at CMU or concrete walls shall be metallic masonry type. Contractor shall closely coordinate masonry rough-ins with masonry wall installer and wall construction method/phasing to provide conduit pathways and junction box installation in coordination with masonry wall installation. Masonry boxes shall be positioned and supported to be flush with the finished wall. For CMU walls, conduit shall route vertically, centered within the CMU block cell. Dimensional locations of all masonry wall rough-ins shall be approved by the Architect prior to installation.

C. Pull Boxes
1. Provide pull boxes where shown for installation of cable supports or where required to limit the number of bends in any conduit to not more than three 90-degree bends.
2. Use galvanized boxes of code-required size with removable covers installed so that covers will be accessible after work is completed.

D. Installation:
1. Boxes and outlets shall be mounted at nominal centerline heights shown on the drawings.
2. Adjust heights in concrete masonry unit (CMU) walls to prevent devices or finish plates from spanning masonry joints.
3. Recessed boxes shall be flush with finished surfaces or not more than 1/8-inch back and be level and plumb. Long screws with spacers or shims for mounting devices will not be acceptable. No combustible material shall be exposed to wiring at outlets.
4. Covers for flush mounted boxes in finished spaces shall extend a minimum of 1/4-inch beyond the box edge to provide a finished appearance. Finish edge of cover to match cover face.
5. Boxes installed attached to a stud in sheet rock walls shall be equipped with opposite side box supports equivalent to Caddy #760. Install drywall screw prior to finish taping. Methods used to attach boxes to studs shall not cause projections on the face of the stud to prevent full-length contact of sheet rock to the stud face.

3.6 PULL WIRES

A. Install nylon pull lines in all empty conduits larger than 1 inch where routing includes 25 feet or more in length or includes 180 degrees or more in bends.

B. Where conduits requiring pull lines are stubbed out and capped, coil a minimum of 36 inches of pull line and tape at termination of conduit for easy future access. Label pull lines as to conduit starting or terminations point and intended future use.

END OF SECTION

CABLE TRAYS 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 1 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section, Common Work Results for Electrical apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Provide a complete cable tray system as indicated.

B. Related Sections include:
   1. Section 25 05 26 Grounding and Bonding for Electrical Systems.
   2. Section 26 05 29 Hangers and Supports for Electrical Systems.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Submit shop drawings indicating materials, finish, dimensions, and accessories.
   2. Show layout, support, and installation details.
   3. Shop drawings shall include seismic installation detail, approved by a registered structural engineer.

B. Product Data: Submit manufacturer's product data, including UL classification.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basket: Cooper B-Line Snake Tray or approved equal.

B. Coordinate with Section 27 05 28.36

2.2 BASKET TRAYS

A. Continuous, rigid, welded steel wire mesh cable management system.
   1. Mesh System: Permits continuous ventilation of cables and maximum dissipation of heat.
   2. Safety Edge: Continuous safety edge T-welded wire lip.
   3. Wire Mesh: Welded at all intersections.

B. Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.

C. Finish for Carbon Steel Wire: Finish applied after welding and bending of mesh.
   1. Electro-Plated Zinc Galvanizing: ASTM B 633, Type III, SC-1.
   2. Hot-Dip Galvanizing: ASTM A 123.
   3. Flat Black: Powder painted surface treatment using ASA 61 black polyester coating.

D. Nominal Dimensions:
   1. Mesh: 2 x 4 inches.
   2. Straight Section Lengths: 120 inches.
   3. Width: 12 inches in corridor, 8 inches in Gymnasium/Cafeteria.
   4. Depth: 4 inches in corridor, 2 inches in Gymnasium/Cafeteria.
   5. Wire Diameter: 0.177 inch, minimum.

E. Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.

F. Support System: Standard.
   1. Wall Installation: CS Bracket. Maximum tray width of 12 inches.
   2. Trapeze Mounting to Ceilings: CS Profile. Maximum tray width of 18 inches.
   3. Ceiling Installation: CSC Bracket. Maximum tray width of 12 inches.
   4. Fasteners: As required by tray widths. Furnished by manufacturer.

G. Support System: Cablofil FAS System
   1. Floor and Wall Installation: FAS Profile.
   2. Wall Installation:
      a. FAS Universal Bracket. Maximum tray width of 24 inches.
      b. FAS L Bracket. Maximum tray width of 12 inches.
   3. Ceiling Installation: FAS C Bracket. Maximum tray width of 12 inches.
   4. Under Floor Support: UFS Under Floor Support Stand.
   5. Fasteners: Not required.

H. Hardware: Hardware, including splice connectors and support components furnished by manufacturer.

I. ACCESSORIES:
   1. Grounding: GTA-2-2 grounding lugs for attachment on tray of continuous ground conductor fixing system.

PART 3 - EXECUTION

3.1 BASKET INSTALLATION

A. Load Span Criteria: Install and support cable management system in accordance with span load criteria of L/240.

B. Cutting:
   1. Cut wires in accordance with manufacturer's instructions.
   2. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
   3. Cut each wire with 1 clean cut to eliminate grinding or touch-up.

C. Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.

END OF SECTION

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section describes conduit, ducts, duct accessories, handholes, boxes and manholes constructed and installed to form a complete underground raceway system.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03 30 00 Cast-In-Place Concrete.

B. Section 31 23 00 Trench, Backfilling and Compacting.

C. Section 31 23 19 Dewatering.

1.3 REFERENCED STANDARDS

A. AASHTO: American Association of State Highway and Transportation Officials.

B. ACI: American Concrete Institute.

C. ANSI: American National Standards Institute.

D. ASTM: American Society for Testing and Materials.

E. NEC: National Electrical Code.

F. NEMA: National Electrical Manufacturers Association.

G. UL: Underwriters Laboratories.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Submit descriptive details of the manufacturers' proposed standard product listings, including:
      a. Precast manholes and handholes.
      b. Precast manhole and handhole accessories, including covers and frames.
      c. Precast concrete 28-day compressive strength data.
      d. Manhole and handhole cement certification.
      e. Duct bank cement certification.
      f. Duct spacers.
      g. Ducts and raceways.
      h. Conduit expansion/deflection fittings.

B. Show drawings for manholes and handholes, including:
   1. Design criteria signed by professional structural engineer licensed by the State of Oregon.
   2. Reinforcing steel locations and concrete covers.
   3. Layout of inserts, attachments, and openings.
   4. Locations and types of joints.
   5. Accessories, including covers, frames, and diamond plate doors where applicable.

C. Duct-Bank Coordination Drawings: show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   2. Drawings shall be signed and sealed by a qualified professional engineer licensed by the State of Oregon.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE HANDHOLES AND BOXES

A. Handholes and boxes shall be precast concrete, 4,000 psi strength at 28 days, with reinforcing and galvanized checker plate traffic covers designed for AASHTO loading of H-20. Wall thickness shall be 3 inches minimum.

B. Precast units shall conform to ASTM C 478. Pulling irons shall be 7/8-inch diameter hot-dip galvanized steel bar with exposed triangular opening.

C. Design:
   1. Precast structures shall be designed in accordance with AASHTO “Specification for Highway Bridges.” Concrete and reinforcing shall be designed in accordance with ACI Code 318.
   2. Tops and walls of structures shall be designed for AASHTO H-20 highway loading, with 30 percent loading added for impact.
   3. Walls shall be designed to withstand all soil pressures, taking into consideration the soil to be encountered and ground water level present at the site.
   4. Assume ground water level is at ground surface unless a lower water table is indicated in the boring logs. Precast handhole pull boxes shall be designed and constructed not to float.

D. All structures shall be identified with manufacturer’s name embedded in, or otherwise permanently attached to, an interior wall face.

E. Covers for handholes and boxes shall be spring-assisted galvanized diamond plate door with locking latch, and shall have 3-inch high markings in weld bead, inscribed before galvanizing with the word, “ELECTRICAL”. Covers shall also have identification such as “MH-PA-1.”

F. Acceptable Manufacturers: Utility Vault Company, Hanson, Renton Concrete Products, or equal.

2.2 PRECAST CONCRETE VAULTS

A. Vaults shall be precast concrete, minimum 4,000 psi strength at 28 days, with reinforcing and cover designed for AASHTO loading of H-20. Wall thickness shall be 3 inches minimum. Access opening shall have 36**]**-inch minimum clear opening.

B. Precast units shall conform to ASTM C 478.

C. Pulling irons shall be 7/8-inch diameter and shall have hot-dip galvanized steel bar with exposed triangular opening.

D. Design:
   1. Precast structures shall be designed in accordance with AASHTO “Specification for Highway Bridges.” Concrete and reinforcing shall be designed in accordance with ACI Code 318.
   2. Tops and walls of structures shall be designed for AASHTO H-20 highway loading, with 30 percent loading added for impact.
   3. Walls shall be designed to withstand all soil pressures, taking into consideration the soil to be encountered and groundwater level present at the site.
   4. Assume ground water level is at ground surface unless a lower water table is indicated in the boring logs. Precast manholes shall be designed and constructed not to float.

E. All structures shall be identified with manufacturer’s name embedded in, or otherwise permanently attached to, an interior wall face.

F. Transformer Vault -
   1. Access cover and frame shall be steel with diamond plate finish.
   2. The frame shall be steel with a 36-inch square opening. The cover shall have holes for lifting and shall have minimum 2-inch high factory label “TELEPHONE,” “ELECTRIC,” or “ELECTRIC HV,” as appropriate or as noted on the drawings.
   3. Acceptable Manufacturers: Utility Vault Company, Hanson, Renton Concrete Products, or equal.

G. Sectionalizing Vault -
   1. Access cover and frame shall be steel with diamond plate finish.
   2. The frame shall be steel with a 36-inch by 72-inch opening. The cover shall be two 36-inch by 36- inch pieces and have holes for lifting and shall have minimum 2-inch high factory label “TELEPHONE,” “ELECTRIC,” or “ELECTRIC HV,” as appropriate or as noted on the drawings.
   3. Acceptable Manufacturers: Utility Vault Company, Hanson, Renton Concrete Products, or equal.

2.3 DUCT LINES

A. Size: Except where otherwise shown on the drawings, ducts and conduits shall not be less than 4-inch trade size.

B. Ducts (concrete-encased): Type II PVC Schedule 40, suitable for use with 90°C rated wire. Conduit shall conform to UL Standard 651 and carry appropriate UL listing for below-ground use.

C. Ducts (direct-buried):
   1. Rigid Non-Metallic Conduit: Type II PVC Schedule 40, suitable for use with 90°C rated wire. Conduit shall conform to UL Standard 651 and carry appropriate UL listing for above- and below-ground use.
   2. Rigid Metal Conduit: UL 6 galvanized rigid steel. Where metal conduit is shown on the drawings or specified below, conduit shall have a coating of 20 mil bonded PVC, or shall be coated with bituminous asphaltic compound.

D. Manufactured bends shall be not less than 36 inches in radius for conduits 4 inches in diameter or larger.

2.4 SPACERS

A. Factory-fabricated rigid PVC vertical and horizontal interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum of 3 inches separation between ducts while supporting ducts during concreting or backfilling. Acceptable manufacturers: Carlon, Orangeberg, or equal.

2.5 GROUND RODS

A. Ground rods shall be copper-clad steel, 3/4-inch diameter and 10-feet long.

2.6 GROUND WIRE

A. Ground wire shall be stranded bare copper No. 6 AWG minimum.

2.7 CONDUIT EXPANSION/DEFLECTION FITTINGS

A. Conduit expansion/deflection fittings in embedded runs shall be rated for indoor use, outdoor use, buried underground, or embedded in concrete in non-hazardous areas.

B. Fittings shall allow axial expansion or contraction up to 3/4 inch and angular misalignment of the axes of the coupled runs in any direction to 30 degrees. Inner sleeves shall maintain constant inside diameter in any position and provide smooth insulated wireway for protection of wire insulation.

C. Fittings shall have a watertight flexible neoprene outer jacket and tinned copper flexible braid grounding strap.

D. Use with galvanized rigid steel conduit or PVC Schedule 40 conduit utilizing rigid metal conduit nipples and rigid metal to PVC adapters.

E. Acceptable Manufacturers: Crouse-Hinds, O-Z/Gendy, or equal.

PART 3 - EXECUTION

3.1 PRECAST MANHOLES AND HANDHOLE PULL BOXES

A. Construction
   1. Units may be precast monolithically or may consist of assembled sections.
   2. Assembled sections shall have mating edges with tongue-and-groove joints. Joints shall be designed to firmly interlock adjoining components, and provide waterproof junctions. Joints shall be sealed watertight using preformed plastic strips installed in accordance with the manufacturer's instructions.
   3. Furnish lifting devices for proper handling of units.
   4. Provide ground rod and sleeve in manhole floors.
   5. Install sump with grate.

B. Duct entries shall be a minimum of 14 inches above floor and below ceiling. Cable supports, clamps, or racks shall be provided. Floor shall slope 2 percent in all directions to a sump. Sump shall be a minimum of 8 inches in diameter.

C. Install pulling irons or inserts for pulling eyes, inserts for cable racks, and openings for conduit entry as required. Steel components other than reinforced steel shall be hot-dip galvanized after fabrication. Manholes and handhole pull boxes shall have concrete bottoms.

D. Install drains in electrical manholes and handhole pull boxes with a minimum 4-inch pipe set in the bottom and terminated in a minimum of 1 cubic yard of drain rock.

3.2 INSTALLATION

A. Install on a level bed of well-tamped gravel or crushed stone, well-graded from the 1-inch to 2-inch sieve.
   1. The top of frame and covers shall be flush with the finished surface of pavements, and flush with finished grade in unpaved areas.
   2. Set manholes and handholes plumb to limit the depth of standing water to a maximum of 2 inches. Unless otherwise specified, manhole covers shall be set at grade.
   3. Construct a sufficient number of precast concrete and mortar courses between top of manhole and manhole frame to reach the required level. Grout the manhole frame to the chimney.

B. Locate underground duct lines and manholes and handholes at the approximate locations shown on the drawings with due consideration given to the location of other utilities, grades, and paving.

C. Provide windows for duct bank terminations and fill with concrete or non-shrink grout after duct placement.

D. Provide pulling irons opposite each duct and conduit entrance. Pulling irons shall be cast in the walls opposite all duct windows approximately 6 inches above the top of the window.

E. Ground Rods and Grounding:
   1. Rods shall protrude approximately 4 inches above the manhole floor.
   2. In precast manholes, drive a ground rod into the earth through the floor sleeve. After the manhole is set in place, fill the sleeve with sealant to make a watertight seal.

F. Ground Wires:
   1. Install ground wires around the inside perimeter of the manhole and anchor them to the walls.
   2. Connect the wires to the ground rods by exothermic welding or approved compression process to form solid metal joints.
   3. Bond the ground wires to the exposed non-current-carrying metal parts of racks, etc., in the manholes. Also bond the wires to duct bank bare equipment grounding conductors.

3.3 TRENCHING

A. Excavate trenches in accordance with Section 31 23 00, Trenching, Backfilling, and Compacting.

B. Work with extreme care near existing utilities to avoid damaging them. Cut the trenches neatly and uniformly.

C. For Concrete-Encased Ducts:
   1. After excavation of the trench, drive stakes in the bottom of the trench at 4-foot intervals to establish the grade and route of the duct bank.
   2. Pitch the trenches uniformly toward manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts towards buildings.
   3. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that the concrete envelope can be poured without soil inclusions. Use forms where the soil is not self-supporting.
   4. After the concrete-encased duct has sufficiently cured, backfill the trench in accordance with Section 31 23 00, Trenching, Backfilling, and Compacting.

3.4 DUCT LINE INSTALLATIONS

A. General
   1. Duct line shall be in accordance with the NEC, as shown on the drawings, and as specified.
   2. Slope duct to drain toward manholes and away from building and equipment entrances. Pitch shall be not less than 4 inches in 100 feet. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 5 feet in the horizontal and vertical directions unless noted otherwise. The use of manufactured bends is limited to building entrances and stub-ups to equipment.
   3. Underground conduit stub-ups to equipment inside buildings shall be galvanized rigid steel and shall extend at least 10 feet outside the building foundation. Stub-ups to equipment, mounted on outdoor concrete slabs, shall be galvanized rigid steel and shall extend at least 5 feet from edge of slab. Install insulated grounding bushings on the terminations. Couple the steel conduits to the ducts with suitable adapters, and encase with 3 inches of concrete.
   4. Upon completion of the duct bank installation, pull a standard flexible mandrel through each duct. The mandrel shall be at least 12 inches long, and shall have a diameter 1/2 inch less than the inside diameter of the duct. After mandreling, pull a brush with stiff bristles through each duct to remove the loosened particles. The diameter of the brush shall be equal to or slightly larger than the diameter of the duct.
   5. Seal the ducts and conduits at building entrances and at outdoor equipment terminations with a suitable nonhardening compound.

B. Direct Burial Duct and Conduits:
   1. Install direct burial ducts and conduits only where shown on the drawings.
   2. Ducts and conduits shall be joined and terminated with fittings recommended by the conduit manufacturer.
   3. Tops of ducts and conduits shall be not less than 24 inches below grade.
   4. Do not kink the ducts or conduits.
   5. Place a continuous strip of utility warning tape approximately 12 inches above ducts or conduits before backfilling trenches. See Section 31 23 00, Trenching, Backfilling, and Compacting, for tape description and installation requirements.

END OF SECTION

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 1 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes: Clearly and properly identify the complete electrical system to indicate the loads served or the function of each item of equipment connected under this scope of work.

B. Related Sections include:
1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
2. Section 26 05 33 Raceways and Boxes for Electrical Systems.
3. Section 26 09 33 Central Dimming Controls.
4. Section 26 22 00 Low Voltage Transformers.
5. Section 26 24 13 Switchboards.
6. Section 26 24 16 Panelboards.
7. Section 26 27 26 Wiring Devices.
8. Section 26 29 00 Motor Controllers.
9. Section 26 32 13 Engine Generators.
10. Section 26 50 00 Lighting.
11. Section 28 30 00 Fire Detection and Alarm.

PART 2 - PRODUCTS

2.1 LABELS

A. Pre-printed: Permanent material pre-printed with black on white, with adhesive backing, Brady, 3M or equivalent.

B. Engraved Laminated Plastic: 3-ply laminated plastic, colors indicated herein, with beveled edges, engraved letters and stainless steel screw attachment. Nameplate length to suit engraving. Adhesive attachment is not acceptable.

C. Clear Plastic Tape: Black (normal) or red (emergency or standby) 12 point Helvetica medium text, clear adhesive backing, field printed with proper equipment for device labeling. Brother P-Touch, Dyno-tape, Kroy, or equal.

D. Wire Markers: White with black numbers, adhesive backed tape on dispenser roll, Brady, 3M or equivalent.

E. Feeder Conduit Marking: Provide one-piece snap-around vinyl feeder conduit markers for feeder conduits. Provide custom label, black letters on orange background indicating destination equipment, 1.25-inch high letters (min) – Seton #M440 Series. Provide additional one-piece snap-around vinyl label, black letters on orange background for voltage designation (i.e. 277/480V, 120/208V). Secure labels to conduits using plastic tie wrap – 2 per label.

F. Marker Pen: Black permanent marker suitable for writing on metallic surfaces.

PART 3 - EXECUTION

3.1 GENERAL

A. Nameplate and text coloring:
1. Normal: Black nameplate with white lettering.
2. Emergency: Orange nameplate with black lettering.

3. Standby: Yellow nameplate with black lettering.
4. UPS: Blue nameplate with white lettering.

3.2 SWITCHBOARDS, DISTRIBUTION PANELS

A. Provide engraved laminated plastic nameplates for all main and feeder protective devices indicating the function or the load served (e.g. ELEV-5, PANEL 4HA, AHU-5, or SPARE) and the protective device trip rating (i.e. 175A). Text height: 3/8-inch.

B. Provide engraved laminated plastic nameplate for all bussed spaces indicating the maximum ampere rating of future breaker, switch or starter that may be installed (e.g. SPACE (225A)). Text height: 3/8-inch.

C. Provide engraved laminated plastic nameplate on the face of equipment enclosure as follows:
   1. Line 1: Equipment identification (e.g. MDP, SDP, or MCC 4H). Text height: 3/4-inch.
   2. Line 2: Equipment voltage, phase and wire quantity (e.g. 480Y/277V, 3PH, 4W). Text height: 1/2-inch.

D. Provide additional engraved laminated plastic nameplate to indicate upstream source and location of upstream source as follows:
   1. Line 1: Upstream source equipment (e.g. FED FROM MDP). Text height: 3/8-inch.
   2. Line 2: Location of upstream source (e.g. MAIN ELEC ROOM 102). Text height: 3/8-inch.
   3. Confirm final room designations with Architect and Owner prior to procurement of nameplates.

3.3 DISTRIBUTION TRANSFORMERS

A. Provide engraved laminated plastic nameplate on the face of the equipment enclosure as follows:
   1. Line 1: Equipment identification (e.g. T-N2P). Text height: 3/4-inch.
   2. Line 2: Equipment kVA rating, primary and secondary voltages (e.g. 150kVA, PRI: 480V, SEC: 208Y/120V). Text height: 1/2-inch.

B. Provide additional engraved laminated plastic nameplate to indicate upstream source and location of upstream source as follows:
   1. Line 1: Upstream source equipment (e.g. FED FROM MDP). Text height: 3/8-inch.
   2. Line 2: Location of upstream source (e.g. MAIN ELEC ROOM 102). Text height: 3/8-inch
   3. Confirm final room designations with Architect and Owner prior to procurement of nameplates.

3.4 BRANCH CIRCUIT PANELBOARDS

A. Provide engraved laminated plastic nameplate on the face of each panelboard centered above the door as follows:
   1. Line 1: Equipment identification (e.g. PANEL 4HA). Text height: 1/2-inch.
   2. Line 2: Equipment voltage, phase and wire quantity (e.g. 480Y/277V, 3PH, 4W). Text height: 3/8-inch.

B. Indicate feeder source, feeder wire size, and feeder breaker or fuse size with plastic tape labels on the inside of the panel door.

C. Provide typewritten panel directories, with protective, clear transparent covers, accurately accounting for every breaker installed including spares.
   1. Schedules shall use the actual room designations assigned by name or number near completion of the work and not the space designation on the Drawings. Confirm final room designations with Architect and Owner prior to completion of work.
   2. Each load description shall include a room or area designation whether indicated on the Drawings or not.

3.5 EQUIPMENT

A. Provide engraved laminated plastic nameplate on the face of all disconnect switches, motor starters, relays, contactors, etc. indicating equipment served (e.g. AHU-1) and equipment load (e.g. 20HP). Provide additional engraved laminated plastic nameplate indicating serving panel designation and circuit number.

B. Provide clear plastic tape label for all relays, contactors, time switches and miscellaneous equipment provided under this Division of work indicating equipment served

3.6 FEEDER CONDUIT

A. Provide feeder conduit marker for all electrical feeders.

B. Markers shall be provided when exiting source equipment and located along the entire conduit length 20ft on centers in exposed areas, above ceilings and upon entering or leaving an area or room.

3.7 DEVICES

A. Label each receptacle plate with preprinted clear plastic tape indicating serving panel and circuit number (e.g. PANEL 2PA-5). Clean all oils, dirt and any foreign materials from plate prior to label application.Receptacles connected to a GFCI protected circuit downstream from the protecting device shall be so labeled.

3.8 RACEWAYS AND BOXES

A. Label all pull boxes and junction boxes for systems with paint or marker pen on box cover identifying system. Where box covers are exposed in finished areas, label inside of cover. Covers shall be color labeled as follows: 480Y/277V wiring - orange; 208Y/120V wiring - black; fire alarm - red; communications - green; security - blue.

B. Label each end of pull wires left in empty conduits with tags or tape indicating location of other end of wire.

3.9 SYSTEMS

A. Complex control circuits may utilize any combination of colors with each conductor identified throughout, using wraparound numbers or letters. Use the number or letters shown where the Drawings or operation and maintenance data indicate wiring identification.

B. Label the fire alarm and communication equipment zones, controls, indicators, etc., with machine printed labels or indicators appropriate for the equipment installed as supplied or recommended by the equipment manufacturer.

END OF SECTION

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
1. Overcurrent protective device coordination study.
2. Arc flash hazard analysis, arc flash boundary calculations and equipment labeling.
3. Recommend device settings and equipment labeling.

B. Related Sections include:
1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
2. Section 26 22 00 Low Voltage Transformers.
3. Section 26 24 13 Switchboards.
4. Section 26 29 00 Motor Controllers.

1.3 REFERENCES

1. IEEE 141 Recommended practice for electrical power distribution and coordination of industrial and commercial power systems.
2. IEEE 242 Recommended practice for protection and coordination of industrial and commercial power systems.
3. IEEE 399 Recommended practice for industrial and commercial power system analysis.
4. IEEE 1584 Guide for performing arc-flash hazard calculations.
5. NFPA 70 National Electrical Code, latest addition.
6. NFPA 70E Standard for Electrical Safety in the Workplace, latest addition.

1.4 SUBMITTALS

A. Coordination study.

B. Device setting recommendations.

C. Arc flash hazard analysis and report.

D. Arc flash equipment labeling recommendations.

E. Arc flash label example.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ETI, Electrical Systems Analysis.

B. Qualified engineers of the switchgear manufacturer.

2.2 STUDIES AND ANALYSIS

A. Coordination Study:
1. Provide a coordination study for the electrical overcurrent devices to assure proper equipment and personnel protection.
2. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the source. The study shall reflect the operation of each device during normal and abnormal current conditions.

3. The Contractor shall provide all pertinent information required by the preparers to complete the study.
4. The complete study shall include a system one-line diagram and protective coordination curves.
    a. The coordination curves shall determine the required settings of protective devices to assure selective coordination. The curves shall graphically illustrate on log paper that adequate time separation exists between series devices. Plot the specific time-current characteristics of each protective device so that all upstream devices are clearly depicted on one sheet.
    b. Time-current curves shall be developed for both phase and ground protective devices.
    c. The following specific information shall also be shown on the coordination curves:
        1) Device identification.
        2) Voltage and current ratio for curves.
        3) 3-phase and 1-phase ANSI damage points for each transformer.
        4) No-damage, melting, and clearing curves for fuses.
        5) Cable damage curve.
        6) Transformer inrush points.
        7) Maximum short circuit cut-off point.
        8) Motor starting locked rotor curves.
        9) Clearly marked short circuit current levels through each protective device and branch.
    d. Develop a table that summarizes the settings selected for the protective devices. Included in the table shall be the following:
        1) Device identification.
        2) Circuit breaker sensor rating, long-time, short-time, instantaneous settings, and time bands.
        3) Fuse rating and type.
        4) Ground fault pickup and time delay.
        5) Provide characteristic time-current curves for each adjustable overcurrent protective device showing pickup settings, time delay bands and device operating times. Include trip adjustment time dials and available settings corresponding to each characteristic time-current curve.

B. Arc Flash Hazard Analysis:
1. Provide an Arc Flash Hazard Study per the requirements set forth in NFPA 70E. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E.
2. Arc flash study to determine:
    a. Arc flash incident energies.
    b. Arc flash boundaries.
    c. Shock hazard boundaries
    d. Personal protective equipment (PPE) for energized electrical equipment.
3. Arc flash study shall provide following information for each system mode of operation and shall be documented. The study results shall include:
    a. Equipment name and voltage.
    b. Equipment device name and ANSI function (i.e. 51/50).
    c. Equipment type, i.e., switchgear, MCC, panel, VFD, etc.
    d. Equipment arc gap.
    e. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
    f. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
    g. Worst-case arc flash boundary for each bus/equipment in the model.
    h. Worst-case arc flash hazard incident energy in cal/cm2 for each bus/equipment in the model.
    i. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.

j. Working distances for up to five different distances showing items g, h, and i for each distance.
k. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm2 and provide recommendations to reduced arc flash energy levels for these areas.
l. Flag results where 85% arcing current provided worst-case results.

4. Arc flash study report format:
   a. Introduction.
   b. Methodology.
   c. Back up information.
   d. Key assumptions.
   e. IEEE 1584-2002 considerations.
   f. Arc flash reduction options: Overcurrent protective device changes.
   g. Explanation of data in arc flash hazard report tables.
   h. NFPA 70E Information.
      1) Shock hazards with covers removed.
      2) Shock hazard approach boundaries.
         a) Limited approach boundary.
         b) Restricted approach boundary.
         c) Prohibited approach boundary.
      3) Arc flash hazard boundaries.
   i. Results of arc flash hazard analysis for high voltage, medium voltage and low voltage systems, including:
      1) Working distances.
      2) Energy levels.
      3) PPE requirements.
      4) Recommendations to reduce arc flash hazard energy and exposure.
   j. Arc flash hazard report.
   k. Electronic file.
5. Provide labels for the project.

PART 3 - EXECUTION

3.1 SETTINGS AND ADJUSTMENT

A. Set and adjust all breakers in the distribution system per the recommendations of the coordination study and settings table.

B. Provide protective covers and locking devices on breakers to secure settings from accidental changes.

3.2 ARC FLASH WARNING LABELS

A. Provide a 3.5 inch x 5 inch thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:
   1. Location designation.
   2. Nominal voltage
   3. Flash protection boundary
   4. Hazard risk category
   5. Incident energy
   6. Working distance
   7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. One Arc flash label shall be provided for each, unit substation primary and secondary side, switchboard, switchgear section, motor control center, panelboard and busway.

3.3 ARC FLASH TRAINING

A. The contractor of the arc flash hazard analysis shall train the owners qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) of equivalent.

END OF SECTION

ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Perform field tests and operational checks to assure that all electrical equipment, both contractor and Owner supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.
   2. The tests and operational check shall determine the suitability for energization.
   3. Schedule tests and give a minimum of one week's advance notice of time and date to the Architect and Owner for any major systems tests specified in this Section.

B. Related Sections include:
   1. Section 01 79 00 Demonstration and Training
   2. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   3. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   4. Section 26 24 13 Switchboards.
   5. Section 26 24 16 Panelboards.
   6. Section 26 29 00 Motor Controllers.
   7. Section 26 32 13 Engine Generators.
   8. Section 26 36 23 Automatic Transfer Switches.
   9. Section 28 30 00 Fire Detection and Alarm.

1.3 TESTING CRITERIA

A. General:
   1. The testing company shall provide the equipment and technical personnel to perform all tests and inspections. The contractor shall, at his expense, furnish any personnel necessary to assist in the testing and inspection.
   2. When the tests and inspections have been completed, a label shall be attached to all devices tested. The label shall provide the name of the testing company, the date of the tests, and the initials of the Engineer who performed the tests.

B. Responsibilities:
   1. The Contractor shall clean the equipment, torque down all accessible bolts according to the equipment manufacturer's instructions, perform routine insulation resistance tests on all branch and feeder circuits, continuity checks on all branch and control wiring, and rotation tests for all distribution and utilization equipment. The Contractor shall furnish a complete set of current plans and specifications to the testing company prior to commencement of any testing. At each test site, the Contractor shall provide any test control power necessary to perform the tests specified. The test organization shall be consulted as to the specific power requirements. The Contractor shall notify the testing organization when the equipment and systems are ready for their inspections and testing. After review by the testing engineer, the Contractor shall correct any deficiencies noted by the testing company.
   2. The Contractor shall be responsible for having the manufacturer of each equipment and/or system provide factory trained representatives(s) that will perform all required functional testing, checkout, and repairs in order to pronounce the equipment and/or systems meet the requirements of these specifications and Drawings and it is ready for startup testing and commissioning by the testing organization as specified hereafter.
   3. The Engineer, in conjunction with the Utility, shall furnish settings of protective devices.

4. The testing organization shall notify the Engineer prior to the commencement of any testing. The testing organization shall set and adjust the protective devices and associated auxiliary timing devices in accordance with the values furnished by the Engineer. The testing organization shall maintain a written record of all tests and, upon completion of the test, include them in a final report. The report shall detail any deficiencies in the system material, workmanship, or design.

C. Implementation:
1. Safety practices shall comply with applicable state and local safety orders, as well as with the Occupational Safety and Health Act (OSHA). Compliance with the National Fire Protection Association (NFPA) standard NFPA 70E, and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.
2. Tests, other than phase rotation and operational tests, shall only be performed on apparatus that is deenergized. The testing company's lead test engineer for the project shall be a designated safety representative and shall supervise testing observations and safety requirements. Work shall not proceed until he had determined that it is safe to do so.
3. Power circuits shall have conductors shorted to ground by a hotline grounding device approved for the purpose. Warning signs and protective barriers shall be provided as necessary to conduct the tests safely.

D. Reports:
1. General: Provide full documentation of all tests in the form of a report.
2. The test report shall include the following sections:
   a. Scope of testing.
   b. Equipment tested.
   c. Description of test.
   d. Test results.
   e. Conclusions and recommendations.
   f. Appendix, including test forms.
3. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair and/or replacement parts. The data sheets shall indicate the name of the engineer who tested the equipment and the date of the test completion.
4. Record copies of the completed test report shall be submitted no more than 30 days after completion of the testing and inspection.

1.4 REFERENCES

A. The testing and inspection shall comply with all applicable sections of the applicable codes and standards listed in Section 26 05 00 of the project specifications.

B. The inspection and testing shall comply with the project plans and specifications, as well as with the manufacturer's drawings, instruction manuals, and other applicable data that may be provided by the Engineer, for the apparatus tested.

1.5 QUALIFICATIONS

A. The testing organization may be an independent division of the manufacturer of the assembled products being tested. If an outside testing organization is utilized, a representative of the manufacturer shall be under contract by the testing company. He shall be present during all testing to ensure the testing is performed properly and that nay deficiencies discovered are promptly corrected.

B. The testing organization shall be a full service company that employs factory trained test engineers capable of troubleshooting, as well as identifying power equipment problems. All work outlined shall be performed under the full time, onsite supervision of a graduate engineer with a minimum of 5 years of field testing experience. Upon request, the testing company shall submit proof of its qualifications.

PART 2 - PRODUCTS

2.1 TESTING EQUIPMENT

A. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain. Instruments shall be calibrated in accordance with the following frequency schedule:
   1. Field Instruments: 6 months maximum.
   2. Laboratory Instruments: 12 months.
   3. Leased Specialty Equipment: 12 months (where accuracy is guaranteed by lessor). Dated calibration labels shall be visible on all test equipment.

PART 3 - EXECUTION

3.1 EQUIPMENT TO BE TESTED

A. Low Voltage Electrical Power Conductors and Cables - Section 26 05 19.
   1. For all circuits rated 400 Amperes or higher perform tests listed in the NETA 2007 Acceptance Testing Specifications for Low-Voltage Cables, section 7.3.2.

B. Switchboards - Section 26 24 13.
   1. Switchboards: Perform tests listed in the NETA 2007 Acceptance Testing Specifications for Switchgear and Switchboard Assemblies, section 7.1.
   2. Circuit Breakers: Perform tests listed in the NETA 2007 Acceptance Testing Specifications for Low-Voltage Circuit Breakers, section 7.6.1.1.

C. Grounding and Bonding for Electrical Systems - Section 26 05 26.
   1. Perform tests listed in the NETA 2007 Acceptance Testing Specifications for Grounding Systems, section 7.13.

D. Panelboards - Section 26 24 16.
   1. Panelboards: Perform tests listed in the NETA 2007 Acceptance Testing Specifications for Switchgear and Switchboard Assemblies, section 7.1. Only those tests applicable to panelboards need be performed, no electrical tests of the circuit breakers need to be performed.

E. Motor Controllers - Section 26 29 00.

F. Automatic Transfer Switches - Section 26 36 23.
   1. Transfer Switches: Perform tests listed in the NETA 2007 Acceptance Testing Specifications for Automatic Transfer Switches, section 7.22.3.

G. Fire Alarm and Detection - Section 28 30 00.
   1. Fire Alarm System: Perform tests listed in Section 28 30 00.

END OF SECTION

PHOTOVOLTAIC SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes Design-Build work.
   1. The intent of Division 26 Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.
   2. Provide a complete Grid Interactive Photovoltaic (PV) System as described below and indicated on the Drawings.
   3. Include all work specified in Division 26 and indicated on Drawings, including appurtenances, connections, fasteners, and accessories required to make a complete working system, whether indicated or not indicated.
   4. Related Sections Include:
      a. Section 26 05 00 Common Work Results for Electrical
      b. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables
      c. Section 26 05 26 Grounding and Bonding for Electrical Systems
      d. Section 26 05 29 Hangers and Supports for Electrical Systems
      e. Section 26 05 33 Raceways and Boxes for Electrical Systems
      f. Section 26 05 53 Identification

B. The Design Build PV electrical system shall be complete with load and system calculations, layout, and shading diagrams, meeting design criteria performed by or under the supervision of a Professional Engineer licensed in the State of Oregon. The Design Build contractor shall be responsible for providing sealed construction and permit drawings.

C. The PV system shall consist of PV modules, mounting system, AC and DC disconnects, power inverters, conductors, conduit, wire management, monitoring devices, over current protection, and all other accessories needed for proper operation. The PV system may also consist of disconnecting combiner boxes and wiring gutters. The complete system is to be integrated into the facility electrical system without impact to the utility service or power quality.

D. The system shall have a minimum output rating at the service voltage indicated on the drawings.

E. The electrical work shall be guaranteed for a period of two (2) years following date of substantial completion.

F. The design shall comply with the Eugene Water and Electric Board's (EWEB) Customer Generation policies.

1.2 WORK INCLUDED

A. Provide a 89 KW Grid Interactive Photovoltaic (PV) System complete as described below and indicated on the Drawings.

B. The PV system shall consist of angled, roof mounted PV modules, perimeter support assembly, power modules, combiner boxes, power inverters, wiring, monitoring devices and over current protection and all other accessories needed for proper operation. The complete system is to be integrated into the facility electrical system without impact to the utility service or power quality.

C. The system shall have a minimum output rating at the service voltage indicated on the drawings.

1.3 QUALITY ASSURANCE

A. Design Build contractor shall have the following certifications:
   1. State of Oregon Tax Credit Certified Technician (TCCT)
   2. NABCEP Entry Level PV Installer (EL)

B. Design Build contractor shall have at least two years of experience installing photovoltaic systems of equivalent size.

C. The PV system shall be the product of a firm regularly engaged in the assembly or manufacture of this equipment. The component parts of the system shall be the product of firms regularly engaged in the manufacture of these parts.

D. It is the intention of these specifications to furnish and install a system that can be properly maintained and serviced without the necessity of carrying expensive parts, stocks or being subjected to the inconvenience of interrupted service due to the lack of available parts.

1.4 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. Underwriters Laboratories (UL):
      a. 1703: Flat Plate PV Modules and Panels Standard for Safety of Static Inverters and Charge Controllers for use in PV Power systems
      b. 1741: Inverters Converters Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
   2. ASTM Standards:
      a. E927: Solar Simulation for Terrestrial PV Testing
      b. E1038: Test Method for Determining Resistance of PV Modules to Hail by Impact with Propelled Ice Balls
      c. E1171: Test Method for PV Modules in Cyclic Temperature and Humidity Environments
      d. E1328: Terminology Relating to PV Solar Energy Conversion
      e. E1462: Test Methods for Solar Insulation Integrity and Ground Path Continuity of PV Modules
      f. E1596: Test Methods for Solar Radiation Weathering of PV Modules
      g. E1799: Test Methods for Visual Inspection of PV Modules
      h. E1802: Test Methods for Wet Insulation Integrity Testing of PV Modules
   3. IEEE Standards:
      a. 928: IEEE Recommended Criteria for Terrestrial PV Power Systems
      b. 929: IEEE Recommended Practice for Utility Interface of PV Systems
      c. 80: IEEE Recommended Grounding Practices
      d. P1262: IEEE Recommended Practice for Qualification of PV Modules
      e. P1373: IEEE Recommended Practice for Field Test Methods and Procedures for Grid-Connected PV Systems
      f. P1374: IEEE Guide for Terrestrial PV Power System Safety
   4. National Electrical Code (NEC):
      a. 690: Solar PV Systems

1.5 CONTRACTOR DESIGN

A. The equipment shown on the contract drawings indicate the general size and approximate location of the photovoltaic system, but does not show all components required. It is the responsibility of the contractor to provide a complete photovoltaic system design and installation as needed to meet obtain permit, and comply with all applicable codes and requirements under this section.

B. Raceway for cabling and sleeves shall be provided in compliance with these specifications.Attachment points of the photovoltaic system to the building structure shall be the responsibility of the design build contractor. Provide coordination with the project architect and structural engineer. Provide calculations and details approved by a registered State of Oregon structural engineer.

1.6 SUBMITTALS

A. Product data.

B. Shop Drawings, to include a complete PV system design for installation by the contractor:
   1. Single line diagram.
   2. Raceway and conductor sizing.
   3. Grounding details.
   4. Plan view and layout drawings.
   5. Voltage drop calculations
   6. Individual array efficiency calculations including tilt and orientation factor, percent shading, and total solar resource fraction.
   7. Structural calculations, details and shop drawings for the PV system support structure and attachment to the building system, with a state of Oregon structural engineers stamp.
   8. Submittal to Architect for installation review and approval.
   9. Submittal to AHJ for permit review and approval.

C. Site test report.

D. Operating and Maintenance Data:
   1. Complete instructions covering the operation and testing of the PV System and associated equipment shall be provided for the facility, together with a manual covering system operation and maintenance. Operation instructions shall include any minor adjustments necessary to obtain optimum operation of the system.
   2. Maintenance instructions shall include complete trouble shooting and diagnostic information, disassembly instructions, assembly instructions and preventive maintenance schedule.
   3. The preventive maintenance schedule shall be in outline form. Include recommended cleaners and specified all necessary service checks. Spare parts books for the array and associated equipment shall also be furnished.
   4. Include data in Operating and Maintenance Manuals specified in Section 260500.

1.7 DOCUMENTATION

A. Installing contractor shall provide complete documentation necessary for permitting, construction, Oregon Business Energy Tax Credit (BETC), , Federal tax credits, additional available incentives, utility interconnection, and utility qualifying facility tariff.

1.8 WARRANTY

A. Installation: The Contractor shall provide the Owner with a full two-year warranty on the entire PV system and all of the installed components, equipment and labor. The warranty shall provide for service at the site including the repair and/or replacement of components found to be defective for one year after project acceptance.

B. PV Modules: The PV modules shall have a minimum 20 year warranty and to exhibit a power output of not less than 80% of rated power.

C. Electronics: The electronic components shall have a ten year warranty. The manufacturer shall repair or replace the defect components in cases of failure due to materials or workmanship.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS & INSTALLERS

A. Manufacturers:
1. Panels: Solarworld, , Sunpower, First Solar, Suntech, , Mitsubishi.
2. Inverters: Xantrex, Fronius, SMA, PV Powered.

B. Installers/Integrators:
   1. Gen-Con Solar Inc. Energy Systems Division
   2. Advanced Energy Systems
   3. Frahler Electric Company
   4. Sunlight Solar

C. Other Manufacturers and Installers: Submit Substitution Request including installed PV capacity, credentials, and ETO solar integrator status in accordance with these specifications. It is permissible for electrical contractors utilizing IBEW photovoltaic trained electricians to team with Solar Integrators who comply with these specifications.

2.2 PHOTOVOLTAIC MODULES (PV)

A. Provide PV modules with quick connect wire leads and physical connections attached to an integrated structural support system.

B. PV Module shall have an interlocking foam support structure and all required hardware to mount and secure the PV assemblies to the building structure. Structure with PV modules shall be capable of withstanding wind loads any direction 90 MPH.

C. Photovoltaic Module: Crystal silicon construction with the following efficiencies (encapsulated cell: 18.8%, module: greater than 12.8%, less than or equal to 67.5Voc). Crystals mounted within a tempered glass envelope.

2.3 COMBINER BOXES

A. Provide DC Combiner boxes with string disconnect and lightning protection. Boxes shall be weatherproof construction with fuses for individual module protection. Provide terminals for the connection of input and output conductors to connect the arrays indicated on plans.

2.4 POWER INVERTER

A. Provide a DC-AC power inverter that is compatible with the PV array output and serving utility requirements. The inverter unit shall be enclosed within a single enclosure and operate unattended in an automatic programmed failsafe mode. Power modules to convert VDC to 480, 3 phase VAC using a power inverter and be UL 1741 listed. The unit shall have the following features:
   1. Conversion of DC source to AC without a battery storage system.
   2. Automatic morning wake up and evening shutdown (less than 1 watt draw at night or when off).
   3. Panel status LCD display with back lighting to provide read out of operating system, input and output voltages, AC currents and wattage. Monitoring points:
      a. PV – input voltage.
      b. PV – desired input voltage (set-point)
      c. Current to grid.
      d. Grid frequency.
      e. Power fed to grid.
      f. Grid impedance.
      g. PV – voltage to earth.
      h. Current from PV-panels.
      i. Energy yield.
      j. Total operating hours.
      k. Total system start ups.
      l. Operation mode.
      m. System error

2.5 TRANSFORMERS

A. Provide dry type isolation transformers as required to establish reference ground for the inverter AC output. Transformers shall be provided with over current protection and size matched with the inverter.

2.6 REMOTE MONITORING

A. Provide CAT5 Modbus communication link monitoring capability to connect to owner's PC. Provide all software required to permit interface with owner's PC and facility DDC system.

PART 3 - EXECUTION

3.1 SYSTEM PERFORMANCE

A. The PV system shall achieve a Total Solar Resource Fraction of not less than 75%, as defined and incompliance with the Oregon Department of Energy.

3.2 EQUIPMENT INSTALLATION

A. Protect all modules and materials during shipping, handling and storage to comply with manufacturer's requirements and to prevent damage to the module glass. Damage to the modules include physical, condensation, temperature changes, sun, chemical, and other. Replace any scratched or damaged modules. Store all equipment in a clean, dry environment.

B. Furnish and install all materials required for a complete and operational system. Provide required structural components and hardware to mount the PV arrays on roof with minimum roof penetrations. Anchor all elevated equipment secure with a safety factor of 4. Coordinate PV array anchor points with building structure tie points. Install combiner box adjacent to solar array panels ground to building steel.

C. Size electrical distribution equipment in accordance with NEC 690.64 (B).

3.3 ELECTRICAL WIRING

A. All power wiring shall be installed in conduit. Conductors installed shall consider route, length and shall be sized to keep voltage drop below 2%. Routing of raceways between PV arrays shall be kept concealed and hid behind panel assemblies. All electrical connections required between the various items of the System shall be provided rung out and tested for continuity prior to energizing.

B. Provide labels for all module leads to indicate negative or positive.

3.4 COORDINATION

A. Coordinate system design with roofing system provided by other Divisions. Provide adequate slope for water drainage. The electrical plans show approximate locations for the solar PV panel arrays and equipment. Contractor shall provide proposed solar PV panel array layout on a scaled roof plan to Architect for review and approval prior to installation of the solar PV system and related pathways and components. Screening of mechanical system roof penetrations shall be observed and considered – coordinate locations with the Architect prior to submittals.

B. Provide remote monitoring equipment with output as directed by Division 23 controls contractor.

3.5 SUPERVISION

A. Installation and start-up shall be supervised, checked and tested by a qualified representative of the PV System manufacturer.

B. Caution needs to be exercised in the installation of the PV modules, in that they can generate lethal voltages when exposed to sunlight. The PV modules will go live with open circuit voltage when they are removed from their enclosed shipping containers. Contractor is responsible for instructing that "energized equipment" protocol be established for those working with and around the installation of the PV modules.

3.6 FIELD TEST

A. After the installation and initial start-up of the PV System set is complete, a test shall be performed and logged in the presence of the Architect. The Contractor shall have the PV System integrator furnish an engineer to monitor the system during the tests, to check all details of the installation and to instruct the operators. This engineer will be required for a period of not less than 2 days for instruction and tests and all costs in connection therewith shall be included in the Contractor's bid. The Contractor shall furnish all instruments necessary to conduct the tests and shall connect all devices required to obtain data required.

B. Field Test Requirements: Data shall be recorded for a 24 hour period. Record all results in the test report. Testing shall be accomplished in the following sequence:
   1. Testing shall be performed on a cloudless day at noon for maximum accuracy.
   2. Check open-circuit voltage of each of the panels to verify that it provides the manufacturer's specified voltage in full sun.
   3. Check open-circuit voltage of each string of panels at string combiner.
   4. Test polarity of all strings in the string combiner. All strings should have the same polarity.
   5. Test the AC line voltage at PV system AC disconnect(s) to confirm that it is with 10% of system rated line voltage.
   6. Test the continuity of all DC fuses to be installed in the DC string combiner box.
   7. Test open circuit voltage at DC disconnect switch to ensure it is within proper limits according to the manufacturer's installation manual.
   8. Test to verify system tolerance is at 90%. Take simultaneous measurements from calibrated solar meter, pyranometer, and inverter output energy over a one hour period in 15 min increments. Use the following formula to calculate the array tolerance:
      a. Tolerance = Inverter Energy Output (Wh) / [Pyranometer (W/m^2) / 1000 (W/m^2) *0.8]
   9. Check islanding disconnect feature.
      a. Under voltage shut-down and disconnection.
   10. Over voltage shut-down and disconnection
   11. Frequency shut-down and disconnection.
   12. Night time shut-down.
   13. PV Array fault condition shut-down and disconnection.

3.7 SUPERVISION

A. Installation and start-up shall be supervised, checked and tested by a qualified representative of the PV System manufacturer.

B. Caution needs to be exercised in the installation of the PV modules, in that they can generate lethal voltages when exposed to sunlight. The PV modules will go live with open circuit voltage when they are removed from their enclosed shipping containers. Contractor is responsible for instructing that "energized equipment" protocol be established for those working with and around the installation of the PV modules.

3.8 ACCEPTANCE

A. Final acceptance shall be made when the PV System set has successfully completed the onsite tests and after all defects in material or operation has been corrected.

END OF SECTION

COMMISSIONING FOR ELECTRICAL

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 provisions of Section 26 05 00, Common Work Results for Electrical apply to work specified in this Section.

C. The Work of this Section is supplemental to and does not supersede any other requirements of the Contract Documents.

1.2 SUMMARY

A. The commissioning process is described in Section 01 91 00 Commissioning.

B. Provide all labor and materials required to complete the commissioning of those Division 26 systems and equipment identified as Commissioned Systems and Equipment in Section 01 91 13 General Commissioning Requirements.

C. Related Sections include:
   1. Section 01 91 13 General Commissioning Requirements.
   2. All Sections of Division 26.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.4 COMMISSIONING SCOPE OF WORK - COMMISSIONING AGENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.5 COMMISSIONING SCOPE OF WORK - CONTRACTOR

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 3 - EXECUTION

3.1 MEETINGS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.2 INSTALLATION, CHECK-OUT, START-UP AND PREFUNCTIONAL CHECKS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.3 FUNCTIONAL TESTING

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.4 TRAINING OF FACILITY OPERATING STAFF AND BUILDING OCCUPANTS

A. Refer to Section 01 79 00 Demonstration and Testing.

END OF SECTION

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 1 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Section includes responsibilities and participation under Division 26 in the automatic dimming system installation and commissioning process.
   2. Installation, connection, adjustment, and testing of the equipment.
   3. Provide qualified personnel for participation in commissioning tests, including seasonal testing required after the initial commissioning.
   4. Providing equipment, materials, and labor necessary to correct deficiencies found during the commission process which fulfill contract and warranty requirements.
   5. Providing Operating and Maintenance Data and Record Drawings to the Test Engineer for verification, organization, and distribution.
   6. Providing assistance to the Test Engineer to develop and edit descriptions of system operation.
   7. Providing training for the systems specified in this Division with coordination by the Test Engineer and Commissioning Agent.

B. Related Sections include:
   1. Section 26 09 23 Lighting Control Devices.
   2. Section 26 09 33 Central Dimming Controls
   3. Section 26 09 43 Network Lighting Controls
   4. Section 26 27 26 Wiring Devices.
   5. Section 26 50 00 Lighting.

1.3 SYSTEM DESCRIPTION

A. System is provided to reduce electric energy consumption during daylight hours by reducing the light output of the electric lighting system in response to measured lighting levels provided by daylight within the building interior.

B. Areas within daylit areas shall have full daylight integration with photocells and automatic dimming and/or switching drivers. Dimming zones will correlate with the distribution of daylight within the space.

C. Areas near exterior glazing shall use dimming drivers and photocells for daylight harvesting and resultant energy conservation.
   1. Daylight sensing equipment will be analog, full range type.
   2. Photocells will measure lighting levels on an affected interior surface. Illumination contribution to this measured surface will include both daylighting and electric lighting (closed-loop system) to ensure proper lighting levels with maximum energy savings.
   3. Logical zones of luminaires will be controlled independently for maximum energy savings while maintaining even task illumination across the entire area between zones. Refer to drawings for control groupings.
   4. Time delay logic will be incorporated to prevent cycling due to clouds and other short-term influences to lighting levels.

D. The control system shall accept indoor, skylight, and outdoor photo sensing heads. Photo sensing control shall permit the user to specify the actual footcandle level where desired switching shall occur.

PART 2 - PRODUCTS

2.1 PHOTOCELLS

A. The photoelectric device for the LED dimming drivers shall be a Class 2, low voltage ambient light sensor designed to connect via 18 gauge shielded cable with the electronic dimming driver. The sensor shall have the following modes of operation:
   1. Automatic dimming of indoor LED lighting in response to the availability of natural daylight. The response range shall be between 0-500 footcandles with a fixed delay of at least 30 seconds.

B. The sensor shall have a flat Fresnel lens with a cone of response. . Quantity and location of sensors shall be determined by manufacturer recommendation and coordinated with architect prior to installation. The wire aperture for both the interface circuit and the sensor shall be no greater than 3/8-inch outside diameter.

C. Acceptable Manufacturers:
   1. The photoelectric sensor used to control the Dimming Electronic Driver shall be a Wattstopper LS-301, or equivalent.
   2. Other “or equivalent” Manufacturers and Products: Submit Substitution Request, complying with requirements of Section 00 16 30, Product Options and Substitutions.

D. All photocells shall be compatible with dimming driver.

2.2 LOW VOLTAGE CONTROL WIRING

A. 18 gauge shielded cable or as recommended by the manufacturer.

2.3 TEST EQUIPMENT

A. Provide multi-function digital Illuminance meter with detachable receptor head with the following characteristics:
   1. Receptor: Silicon photocell type
   2. Illuminance Units: Lux or footcandles (switchable)
   3. Measuring range: 0.1 to 19,990 lux, 0.01 to 1,999 footcandles
   4. Accuracy: ±4% ±1 digit of displayed value
   5. Cosine Correction Characteristics: Within ±1% at 10°; within ±5% at 60°.
   6. Measuring functions: Illuminance, integrated illuminance, average illuminance.
   7. Temperature/humidity drift: Within ±3% ±1 digit (of value displayed at 20°C/ 68°F) within operating temperature/humidity range.
   8. Operating conditions: 0 to 40°C (32 to 104°F) at less than 85% humidity.

B. Provide proof of calibration within 12 months of use. Calibration shall be performed by an independent calibration lab approved by the manufacturer of the meter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Photocell shall be installed surface mounted on recessed junction box in location best suited for accurate measurement. Avoid placement in high traffic or confined spaces.

B. Provide to Architect prior to installation layout drawings indicating proposed location of all photocells and control groups. Proceed with installation after review and acceptance by Architect.

C. Wiring shall be installed in conduit where running through inaccessible areas. Plenum rated wiring shall be allowed in accessible ceiling spaces.

D. Coordinate low voltage wiring connection and location with luminaires to be controlled.

3.2 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the system can be powered, tested, adjusted, and otherwise commissioned. Under Division 26, complete systems, including all subsystems, so they are fully functional. This includes the complete installation of all equipment, materials, wire, controls, etc., in accordance with the contract documents and related directives, clarifications, change orders, etc.

B. A commissioning plan will be developed by the Test Engineer and approved by the Commissioning Agent. Under Division 26, assist the Test Engineer and Commissioning Agent in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If system modifications and clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner. If Contractor initiated system changes have been made that alter the commissioning process, the Commissioning Agent will notify the Owner.

C. Specific pre-commissioning responsibilities under Division 26 are as follows:
   1. Factory startup services for the following items of equipment:
      a. Lighting Control System
   2. Normal startup services required to bring each system into a fully operational state. This includes complete installation and cleaning. The Test Engineer will not begin the commissioning process until each system is documented as being installed complete.

D. Commissioning shall begin after installation of all interior and exterior finishes including but not limited to adjacent roofing, finished floor, wall, and ceiling systems including final painting, all furniture and book stacks in place, and all other building systems which have direct or indirect influence on the performance and distribution of the daylight and electric lighting systems. Start of commissioning before such items are complete will not relieve Contractor from completing those systems in accordance with the Construction Schedule.

3.3 SEQUENCE OF COMMISSIONING

A. Provide to Architect prior to start of commissioning layout drawings indicating proposed location of all measurement points. Proceed with commissioning after review and acceptance by Architect.

B. All illuminance measurements shall be oriented horizontal, facing up, at 30 inches above finished floor. All measurements for a control group shall occur at the same location. Ensure constancy of local surface reflectance conditions throughout commissioning of each control group.

C. Ensure no personnel or outside influence affects the amount of flux striking the receptor head during the recording session.

D. Document measurements in clearly understandable format for review by the Architect. Include time of measurement, temperature, and relative humidity.

E. Measure illuminance at least two hours after local sunset with full output of all electric lighting. Record integrated illuminance and average illuminance for a two hour period.

F. During daylight hours, measure illuminance with all electric lighting off, including emergency and "nightlight" circuits. Record integrated illuminance and average illuminance for a two hour period. Document in clearly understandable format for review by the Architect.

G. Set each photocell to 150% of electric-only lighting contribution.

H. After initial setpoint has been set, measure illuminance in 10 minute increments from 1 hour before to 1 hour after local sunset.

I. Submit all recorded data to Architect for review.

3.4 SEQUENCE OF OPERATIONS FOR LIGHTING CONTROLS

A. Control Approach:
   1. Open public spaces and exterior lighting shall tie to the BMS.
   2. Enclosed spaces shall be stand-alone, controlled via occupancy or vacancy sensors.
   3. Electrical, mechanical, IT, MDF, and IDF and rooms where personal safety is a concern will have line voltage switches only. A large sign will be placed on the back side of all doors exiting the space with the words “TURN OFF THE LIGHTS” in large contrast font. Coordinate sign with architect prior to installation.
   4. Theatrical house lighting shall tie to central dimming panels for preset scene control. Theatrical lighting connected to rigging system shall tie to gateways for DMX protocol.
   5. The gymnasium shall be controlled by a local room control with digitally distributed relays for preset scene control.

B. Sequence of Operations:
   1. Exterior Lighting
      a. Building mounted lighting shall turn on and off by astronomical timeclock for dusk to dawn operation. Confirm with owner and provide timeclock schedule if requested.
      b. Parking lot lighting shall turn on and off in two sequences as defined in the relay schedule. One zone shall turn on/off by astronomical timeclock for dusk to dawn operation. One zone shall turn on by astronomical timeclock and off at 10pm. Confirm with owner and provide timeclock schedule if requested. One of the two circuits of each light pole shall tie to integral occupancy sensor.
      c. Site lighting along sidewalks and pathways shall turn on and off by astronomical timeclock for dusk to dawn operation. Confirm with owner and provide timeclock schedule if requested.
      d. Accent lighting and plaza lighting shall turn on by astronomical timeclock at dusk and off by timeclock at 10pm. Confirm schedule with owner.
      e. Local override for all exterior lighting shall be located in Custodial office. Switch shall be an illuminated switch by Lev-Lok.
   2. Public Spaces
      a. All lighting in the open seating, circulation, elevator lobbies, entrance lobbies and 2 story space will operate on the BMS that will turn lighting on 30 minutes before “open” and shut off 30 minutes after “closed” hours. Verify Open and Closed hours of operation with owner prior to programming.
      b. Circulation areas, hallways, and open plan work will have OS/VS overrides during “closed” hours. These will turn emergency egress lights on to 100% when occupancy is detected, but will turn them off after 10 minutes without movement. OS/VS will be inactive during the day.
      c. All open spaces and circulation have manual override, where required by code (see drawings)
      d. Public Toilets will be controlled via local occupancy sensor. Auto on/ Auto off. Provide keyed override switch for maintenance
      e. Storage and support spaces will have occupancy sensors and manual switch. Room controls are to be manual on, auto off with a 15 minute time delay.
      f. Electrical and mechanical spaces will have manual switch only for safety.
   3. Classrooms:
      a. Stand-alone room control via non-dimming switches and vacancy sensors.
      b. Closed loop photocell to monitor lights in the indicated daylight zone for 0-10V gradual dimming. Photocells shall be set to 30fc with a 5 minute dead-band.
   4. Science and Makers Labs:
      a. Stand-alone room control via non-dimming switches and vacancy sensors.
      b. Photocells integral in the luminaire to provide individual 0-10V gradual dimming. Photocells shall be set to 50fc with a 5 minute dead-band.

5. Private Offices and Admin Areas:
    a. Each room will have a wall box dimmer and vacancy sensor.
    b. Lights remain off until manually engaged by an occupant. Vacancy sensors do NOT automatically turn electric lights on if someone enters the room, but will turn lights off after 30 minutes of non-occupancy. Sensitivity should be set to maximum.
    c. In offices where daylight harvesting is required, photocells shall be set to 30fc with a 5 minute dead-band.
6. Conference Rooms:
    a. Stand-alone room control via non-dimming switches per zone.
    b. Vacancy sensor time delay shall be set to 30 minutes.
7. Gymnasium
    a. Lights turn on by timeclock as defined by the owner, during normal operating hours. Locked box to contain the room controller for scene definition. (5) button switch located at all entries around the room for pre-set scene control and activeation of lighting after hours.
    b. Open loop photocell to monitor lights in the indicated daylight zones for 0-10V gradual dimming. Photocells shall be set to 50fc with a 5 minute dead-band.
8. Drama / Stage / Choral / Commons
    a. The Drama / Stage and Choral areas will have a graphical user interface to define and program lighting scenes of loads tied to the theatrical lighting system. A combination of housing lighting and theatrical DMX lights can create these scenes.
    b. On a regular basis these preset scenes can be recalled via the (5) button wall station located at each entry.
    c. When the Commons is operating as a cafeteria light will be on by timeclock with local override. Open loop photocell to monitor lights in the indicated daylight zones for 0-10V gradual dimming. Photocells shall be set to 40fc with a 5 minute dead-band.
    d. When the Commons operates as an audience location for performances, the local (5) button wall stations will active a preset scene, with 0-10V dimming capability of the linear light to less than 1%, and switching of the decorative pendants.
9. Media Room C3
    a. A slave panel from the theatrical dimming panel will be located for the Media room lighting. A graphical user interface to define and program lighting scenes of loads tied to the theatrical lighting system. A combination of housing lighting and theatrical DMX lights can create these scenes.
10. All other spaces
    a. Sequence of operations will be provided upon written request for all spaces not listed. Reprogramming may be required of some spaces on site after installation to tune the system and meet the owner, daylight and energy management needs. Provide additional programming for reconfiguration up to 24 hours at no additional cost to the owner or design team.

3.5 TESTING FOR SEASONAL VARIATIONS

A. Timing of Commissioning:
1. Initial commissioning shall be performed to best suit the current time-of-year and cloud cover conditions.
2. Seasonal commissioning pertains to testing under full sunlight and full overcast conditions during summer and winter solstice, as well as similar conditions at the spring or fall equinox.
3. Initial commissioning shall be done as soon as contract work is completed regardless of season.
4. Subsequent commissioning shall be undertaken thereafter to ascertain adequate performance during the four seasons.

3.6 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start up all systems within Division 26. These same technicians shall be made available to assist the Test Engineer and Commissioning Agent in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested and coordinated by the Test Engineer. Under Division 26, ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem resolutions at no additional cost to the Owner.

B. System problems and discrepancies may require additional technician time, Test Engineer time, Commissioning Agent time, redesign, and reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained at no additional cost to the Owner.

C. The Commissioning Agent reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service the commission the equipment, and a willingness to work with the Test Engineer and Commissioning Agent to get the job done. Technicians shall be removed from the project at the request of either the Test Engineer or Commissioning Agent.

3.7 RESOLUTION OF DEFICIENCIES

A. In some systems, misadjustments, misapplied equipment, and deficient performance will result in additional work required to commission the systems. This work will be completed under the direction of the Architect, with input from the Contractor, equipment supplier, Test Engineer, and Commissioning Agent. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Architect will have final jurisdiction on the necessary work to be done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Agent deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Agent will notify the Owner, indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.

C. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services, equipment, or both, to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor’s responsibility.

3.8 TRAINING

A. Participate in the training of Owner’s engineering and maintenance staff, as required in Divisions 1 through 28, on each system and related components. Training, in part, will be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids. All training classroom sessions and file demonstrations will be videotaped and copies of this material will be provided as part of closeout requirements.

B. Training will be conducted jointly by the Test Engineer, Commissioning Agent, the Contractor, and the equipment suppliers. The Test Engineer will be responsible for highlighting system peculiarities specific to this project.

3.9 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 1, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. Division 26 Record Drawings shall include architectural floor plans and the individual daylight control systems in relation to actual building layout. These Record Drawings shall also be provided in AutoCad .Dwg format for transmittal to the Test Engineer.

END OF SECTION

CENTRAL DIMMING CONTROLS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Electrical Contractor, As Part Of The Work Of This Section, Shall Provide, Install And Test A Complete Lighting Control System As Specified Herein For Areas Indicated On The Drawings And Circuit Schedules.

B. The Electrical Contractor Shall Furnish All Conduit, Wire, Connectors, Hardware And Other Incidental Items Necessary For The Complete And Proper Operation Of The Lighting Control System.

C. The Electrical Contractor Shall Coordinate All Work Described In This Section With All Other Applicable Plans And Specifications, Including But Not Limited To:

D. General Conditions
   1. Electrical Section General Provisions
   2. Conduit
   3. Wire and Cable

1.2 SYSTEM DESCRIPTION

A. The System Shall Be Designed For The Control Of Architectural And Theatrical Lighting And Shall Consist Of Factory Pre-Wired Dimming And Processing Rack Enclosures Containing Dimmers, Relays, Power Supplies, Breakers, Terminals And/Or Control Electronics.

B. System Shall Work In Conjunction With Specified Low-Voltage Control Stations.

1.3 SUBMITTALS

A. Manufacturer Shall Provide Electronic Sets Of Full System Submittals. Submittals Shall Include:
   1. Full system riser diagram(s) illustrating interconnection of system components, wiring requirements, back box sizes and any special installation considerations.
   2. Full set of printed technical data sheets.
   3. Detailed set of dimmer schedules
   4. Detailed set of circuit and control schedules, including a complete list of all deviations from specifications.

B. Manufacturer Shall Provide Any Additional Information, Including Equipment Demonstrations, As Required By The Engineer Or Specifier To Verify Compliance With Specifications.

1.4 QUALITY ASSURANCE

A. Manufacturer Shall Be One Who Has Been Continuously Engaged In The Manufacturer Of Lighting Control Equipment For A Minimum Of Ten Years. All Dimmer and Cabinet Fabrication Must Take Place In A U.S. Manufacturing Plant.

B. The Manufacturer Shall Have A Factory Authorized Stocking Service Center With At Least One Full Time Service Technician On Staff Located Within 150 Miles Of The Job Site. In Addition, The Manufacturer Shall Have A Toll Free 24-Hour Hotline With A Maximum Response Time Of 20 Minutes, 24 Hours A Day And 365 Days A Year.

C. All Equipment, Where Applicable Standards Have Been Established, Shall Be Built To The Standards Of Underwriters Laboratories, Inc., The National Electric Code And The United States Institute For Theater Technology. Permanently Installed Power Distribution Equipment Such As Dimmer Racks And Distribution Shall Be UL And C-UL Listed, And/Or CE Marked (Where Applicable) And Bear The Appropriate Labels. Portable Equipment Such As Consoles And Fixtures Shall Be UL And C-UL Listed, ETL Listed And/Or CE Marked (Where Applicable) And Bear The Appropriate Labels.

1.5 ACCEPTABLE MANUFACTURERS

A. The Equipment Herein Specified Shall Be Manufactured By:
   1. Electronic Theatre Controls:
      PO Box 620979
      Middleton, WI 53562
      Phone: 608/831-4116
      Fax: 608/836-1736

B. Alternative Manufacturers Must Submit A Full Pre-Approval Package Ten Days Prior To Bid Date. Package Shall Consist Of Items Listed In Part 1, Section 1.03A.

C. Permission To Bid Does Not Imply Acceptance Of The Manufacturer. It Is The Sole Responsibility Of The Electrical Contractor To Ensure That Any Price Quotations Received And Submittals Made Are For Controls Systems That Meet Or Exceed The Specifications.

PART 2 - PRODUCT

2.1 ETC DMX SMART-BAR

A. Manufacturer:
   1. Electronic Theatre Controls:
      PO Box 620979
      Middleton, WI 53562
      Phone: 608/831-4116
      Fax: 608/836-1736

B. General Information
   1. 6 dimmer contained power and control bar with top 16 Amp may power feed
   2. 2500V isolation between control and power components
   3. 75w min load per dimmer
   4. 6x2.3 kw –3m 3 phase power connectors – 10a magnetic breaker for each output
   5. Sleeved suspension points for and mounting hardware/hook clamps with safe working load of 100kg
   6. Convection cooled with max ambient temp of 40 deg. C
   7. DMX 512 in and thru-wire via 5 pin XLR connectors

2.2 ARCHITECTURAL CONTROL PROCESSOR MODULES

A. Control Processor Modules
   1. The Architectural Control Processor shall be the Unison Paradigm P-ACP Series Control Processor as manufactured by Electronic Theatre Controls, Inc., or equal.
   2. Mechanical
      a. The Architectural Control Processor (ACP) assembly shall be designed for use in DRd Series Dimming Enclosures and ERn Series Control Enclosures.
      b. The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.
      c. ACP module electronics shall be contained in a plug-in assembly.
         1) The module shall be housed in a formed steel body and contain no discrete wire connections.
            a) No tools shall be required for module removal or insertion.
      d. The ACP shall be convection cooled.
      e. User Interface
         1) The ACP shall utilize a backlit liquid crystal display capable of graphics and eight lines of text.
         2) The ACP shall provide an alpha-numeric keypad for data entry and navigation
         3) The ACP shall provide a touch-sensitive control wheel for navigation.
         4) The ACP shall provide shortcut buttons to assist in navigation, selection, and data entry.
         5) The ACP keypad, buttons, and wheel shall be backlit for use in low-light conditions.
            a) The backlight shall have a user selectable time out, including no time out.

f. The ACP shall provide a front-panel RJ45 jack for Ethernet connection to the processor for configuration, live control, and web-browser-based system access.
    1) The Ethernet port shall be secured behind the locking door.
g. The ACP shall provide a Secure Digital (SD) Removable Media slot on the front panel for transfer of configuration data.
    1) The SD slot shall be secured behind the locking door.
h. The ACP shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.
    1) The USB port shall be secured behind the locking door.
i. Architectural Lighting System configuration and program information shall be stored in flash memory, which does not require battery backup.
    1) The ACP shall provide a Compact Flash (CF) Card as backup flash memory and storage.
    2) The CF Card is stored in the back of the ACP, and can be accessed only by removing the ACP.
    3) The ACP data can be exchanged by inserting the CF card into another ACP.

3. Electrical
    a. The ACP shall require no discrete wiring connections; all wiring shall be terminated into Dimming or Control Enclosure.
    b. The ACP shall require low-voltage power supplied by the Dimming or Control enclosure.
    c. The ACP shall be hot-swap capable.
    d. The ACP shall support Echelon LinkPower communications with remote devices, including button stations, button/fader stations, Touchscreen stations, sensors, and third party LonMARK compliant products.
        1) The LinkPower network shall utilize polarity-independent, low-voltage Class II twisted pair wiring, type Belden 8471 (unshielded) or Belden 8719 (shielded) or equivalent. One # 14 AWG drain wire will be required for system not using grounded metal conduit. Touchscreen stations, interface stations and portable stations connectors will also require (2) #16 AWG wires.
        2) The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.
        3) Link power wiring shall permit a total wire run of 1640 ft. (500m) without a repeater. Repeater option modules shall be available to increase wiring maximums in increments of 1640 ft. (500m)
        4) Link power wiring between stations shall not exceed 1313 ft. (400m).
    e. The ACP shall support 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking using TCP/IP, ESTA BSR E1.17 Advanced Control Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols for internal communication and integration with third-party equipment.
    f. The ACP shall support EIA-RS232 serial protocol for bi-directional command and communication with third-party equipment.
    g. The ACP shall support two discrete ESTA DMX512A ports, configurable as input or output ports.*
        1) *When used in a Dimming Enclosure, the second port is always an output port.
    h. The ACP shall provide four onboard dry contact closure inputs for integration with third-party products.
    i. The ACP shall provide four onboard contact closure outputs, rated at 1A@30VDC, for integration with third-party equipment.

4. Functional
    a. Capacity
        1) Shall support 1024 channels of control
        2) Shall support 2 physical DMX ports, each of which may be configured as an input or output
    b. System
        1) Runtime application shall utilize support Net3 system interoperability
        2) System shall support the use of Network Time Protocol for real time clock synchronization
        3) System shall support remote firmware upload an over Ethernet connection from a connected PC running the Light Designer software or another connected processor.
        4) System shall support local firmware upload from removable media (SD Card, USB Flash Drive)
    c. Diagnostics
        1) Shall output an Event log
        2) Standard log shall store a fixed-length history of recent activity
        3) Separate critical log shall only store important messages (such as boot-up settings)
    d. Configuration Data
        1) Configuration Data can be uploaded over an Ethernet connection from a PC running Light Designer application
        2) Configuration Data can be retrieved from another Paradigm Processor
        3) A Paradigm Processor shall make its configuration data available for retrieval by another Processor as a backup/recovery mechanism
        4) Configuration Data shall be stored on solid-state media that can be removed to facilitate transfer between Processor units
        5) Configuration Data may be loaded to and from removable media access provided on front panel
        6) Configuration Data for the entire System shall be available for download from any single Processor
        7) Shall store configuration data for Dimming enclosure processors and shall make available for download
    e. Scalability
        1) Adding additional Processors to a System shall proportionately increase its overall capabilities up to a maximum System size
        2) The maximum number of Processors configured as a System shall be at least 12
        3) Multiple Processors shall utilize the Ethernet network to remain time synchronized and share control information
        4) Multiple Processors shall utilize the Ethernet network to maintain configuration data synchronization as modifications are made
        5) Failure of a single Processor shall not prohibit continuing operation of the remaining Processors
        6) It shall be possible for multiple Systems to coexist on the same physical network with logical isolation between Systems
    f. Local User Interface
        1) Shall provide access to Processor setup (IP address)
        2) Shall provide access to Processor status and diagnostics
        3) Where the Processor is installed within a Dimming enclosure, shall provide access to Dimming enclosure setup, status and diagnostics
        4) Shall provide control functionality for Control Channels, Zones, Fixtures, Groups, Presets, Macros, Walls and Sequences within the current configuration.
        5) Shall provide functionality to schedule astronomical and real time events (add/edit/delete)
        6) Shall allow for display of local DMX information
        7) Shall allow for transfer of log files to local removable media
        8) Shall allow to perform firmware upgrades for connected Dimming enclosures
        9) Shall allow for transfer of configuration to and from Dimming enclosures using removable media

10) Shall allow for transfer of configuration to and from LCD Stations using removable media
11) Shall allow for binding of Stations

g. Access Controls
1) There shall be 2 user accounts - Administrator, and User with separate password protection
2) Account and password settings shall be local to each Processor
3) Access Controls shall be applied to certain areas of the Paradigm Local User Interface and Web Interface

h. Web User Interface
1) Shall be an internal web server accessible via Ethernet port
2) Shall support common web browsers on Windows and Mac platforms
3) Shall provide functionality to Activate and Deactivate Presets
4) Shall provide functionality to schedule timed events (add/delete)
5) Shall display status information
6) Shall display log files
7) Shall allow for configuration of Processor settings (date, time)
8) Shall allow for upload and download of configuration data
9) There shall be links to other web-enabled devices in the System, including other Paradigm Processors.

i. Stations
1) Stations shall be connected to a Paradigm Processor via a LinkPower network or Ethernet
2) Station discovery and binding shall be accomplished from the Local User Interface or Light Designer

j. Net3 and ACN Devices
1) Net3 Devices shall be connected to and controlled from Paradigm Processors via Ethernet
2) Paradigm Processors shall provide DMX-Net3 gateway functionality
3) It shall be possible to send and receive Macro triggers defined within the System configuration via Net3
4) There shall be support for Streaming ACN on up to 24 universes per Processor

k. Operation
1) When contained in an dimming enclosure, a snapshot of the dimming enclosure output data shall be stored in persistent memory so that hardware can access it for immediate output on boot
2) DMX output refresh rate shall be configurable
3) There shall be support for 16-bit DMX Attributes
4) DMX inputs may be patched to DMX and Streaming ACN outputs as external sources
5) Streaming ACN inputs shall be patched to DMX outputs (gateway) as external sources
6) Where there are multiple external sources then priority and HTP shall be used to perform arbitration
7) External and internal sources shall be arbitrated based on user-selection of standard or custom rules
8) On Preset Record, the values of Attributes within the Preset shall be updated to reflect the current output
9) The total output may be the combination of many different Presets running concurrently
10) There shall be no hard limit on number of concurrent cross fades
11) Multiple Presets controlling the same Attribute shall first interact based on priority and second based on Latest Takes Precedence(LTP) or Highest Takes Precedence (HTP)
12) LTP and HTP operation shall be supported simultaneously and interact (at the same priority) using HTP
13) Settings due to LTP Presets may be automatically discarded from operation when overridden
14) It shall be possible to specify that a Preset or Attribute Control will persist when overridden
15) A Preset may be designated as an HTP Override and shall cause HTP values to be discarded

16) It shall be possible to modify the rate of a Preset (Cross fades, Effects) from a Control within the System
17) Each Preset shall have a status that can be Activated, Deactivated or Altered
18) Preset status may be set based on matching levels in the current output as an option
19) On startup the System shall be capable of automatically executing timed events within the previous 24 hours to synchronize its initial output state with the current time of day

l. Serial Input/Output
1) RS232 shall support 8-bit word length, parity selection and 1 or 2 stop bits
2) RS232 shall support baud rates from 4800 to 115,200 bps
3) Serial input and output messages are fully customizable
4) Serial output messages can be generated by any Control or Event

2.3 CENTRAL LIGHTING SERVER

A. The Architectural Control Server Shall Be The Unison Paradigm Central Control Server (P-CCS) As Manufactured By Electronic Theatre Controls, Inc., Or Equal.
1. Connections shall be made between lighting system components over standard Ethernet distribution systems using 10/100BaseT.
2. The server shall be tested to UL standards and labeled ETL Listed
3. The server shall be RoHS Compliant (lead-free)
4. The server shall be CE compliant

B. Mechanical
1. The Central Control Server (P-CCS) assembly shall be designed for use with Unison Paradigm Series Control Systems
2. P-CCS electronics shall be contained in a single assembly.
a. The assembly shall be housed in a formed steel body
b. The server shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, powder coat paint
c. Mounting holes shall be provided for installation of a rack mount kit
3. User Interface
a. The P-CCS power button shall be backlit for use in low-light conditions.
4. The P-CCS shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.
5. The P-CCS shall provide rear-panel connections for (2) RJ45 jack for Ethernet connection to the processor for configuration, Virtual Touchscreen (VTS) and web-browser-based system access.
6. Architectural Lighting System configuration and program information shall be stored in solid state memory, which does not require battery backup.
a. The P-CCS shall provide a hard drive for storage of system configurations

C. Electrical
1. The P-CCS shall support 100-240VAC power input and utilize an external transformer power supply
2. The P-CCS shall allow for nearly silent operation
3. The server shall utilize microprocessor based, solid state technology to provide multi-processor lighting and building control
4. The server shall provide two IEE802.3u Ethernet connections for 100BASE-TX communication with the lighting control system
a. The Primary Ethernet port shall be reserved for connection to the lighting control system
b. The Secondary Ethernet connection shall be used for interface with BACnet IP enabled building systems
c. Both Connections shall support Virtual Touchscreen (VTS) functionality
5. Following a loss of power, the P-CCS shall return to its previous power state upon power being restored

D. Environmental
1. The ambient operating temperature shall be 0° to 40°C (32° to 104°F)
2. The storage temperature shall be -40° to 70°C (-40° to 158°F)
3. The operating humidity shall be 5% - 95% non-condensing

E. Functional

1. Capacity
    a. Shall support up to 48 Paradigm Architectural Control Processors (ACP)
    b. Shall support up to 12 individual projects
2. System
    a. Shall support multi-user LiveControl and LiveEdit simultaneously
    b. System shall support the use of Network Time Protocol for real time clock synchronization
    c. System shall support remote firmware upload over an Ethernet connection from a connected PC running the LightDesigner software
    d. Failure of a single Processor shall not prohibit continuing operation of the remaining connected system
    e. Shall log system error messages using Syslog
    f. The server shall support ANSI E1.17 Architecture for Control Networks (ACN)
        5) Servers that do not support ANSI E1.17 shall not be acceptable
    g. The server shall support ANSI/ ASHRAE BSR135.1 BACnet IP protocol.
        6) Servers that do not support BSR135.1 shall not be acceptable
3. Diagnostics
    a. Shall output an Event log using Syslog format
    b. Standard log shall store a fixed-length history of recent activity
    c. Separate critical log shall only store important messages (such as boot-up settings)
4. Configuration Data
    a. Configuration Data can be uploaded over an Ethernet connection from a PC running the LightDesigner application
    b. Configuration Data can be retrieved from any connected Paradigm Processor
    c. Configuration Data may be loaded to and from removable media (USB) access provided on front panel
    d. Configuration Data for the entire System shall be available for download from any Processor or Central Server
    e. Configuration Data shall be stored on solid-state media
5. Scalability
    a. Adding additional Processors to a Server System shall proportionately increase its overall capabilities up to a maximum System size
    b. The maximum number of Processors configured as a single System shall be at least 12.
    c. The maximum number of Paradigm Processors supported by a single Server configuration shall be at least 48
    d. Multiple Processors shall utilize the Ethernet network to remain time synchronized and share control information
    e. Multiple Processors shall utilize the Ethernet network to maintain configuration data synchronization as modifications are made
    f. It shall be possible for multiple Systems to coexist on the same physical network with logical isolation between Systems
    g. Shall provide building management interface separate from the Lighting Network using BACnet IP
        7) Shall allow for system Timed Event scheduling from another device
    h. Shall allow remote use of the customized Virtual Touchscreen Application (VTS)
6. Web User Interface
    a. Shall be an internal web server accessible via the primary Ethernet port
    b. Shall support common web browsers on Windows and Mac OS platforms
    c. Shall provide functionality to Activate and Deactivate Presets
    d. Shall provide functionality to schedule timed events (add/delete)
    e. Shall display status information
    f. Shall display log files
    g. Shall allow for configuration of Processor settings (date, time)
    h. Shall allow for upload and download of configuration data
    i. There shall be links to other web-enabled devices in the System, including other Paradigm Processors
7. Virtual Touchscreen Stations
    a. A Virtual Touchscreen (VTS) interface shall be supported from the Central Control Server
    b. General

1) Virtual Touchscreen stations shall support default and fully graphical control pages.
2) The Virtual Touchscreen station shall operate using graphic buttons, faders and other images with support for at least 30 separate programmable control pages.
3) Virtual Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.

c. Functional
   1) System
      a) The Virtual Touchscreen shall support configuration firmware upload from a Paradigm Central Control Server as proxy
      b) The Virtual Touchscreen shall support client application download from the Paradigm Central Control Server
      c) A minimum of 48 Virtual Touchscreens Stations shall be supported for the Central control Server
      d) Virtual Touchscreens shall support user configurable resolutions up to 1080 HD (1920 x 1080)
      e) Virtual Touchscreen Station shall support configuration form ControlDesigner Software
   2) Setup Mode
      a) There shall be a setup display that is separate from any user-defined configuration
      b) It shall be possible to view and modify connectivity settings
      c) It shall be possible to view status information
      d) The appearance of the setup display shall be standard and not editable
      e) The setup display may be invoked from within the user-defined configuration and/or physical button on the Virtual Touchscreen
      f) There shall be a default protected method to invoke the setup display
   3) Configurations
      a) Only one VTS configuration may be active on a single interface
      b) Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration
      c) Each configuration shall be identified as a different Station within the System

4) Operation
   a) The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Virtual Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.
   b) System macros and sequences shall be programmable via LightDesigner system software.
   c) System time clock events shall be programmable via the Virtual Touchscreen, LightDesigner system software, the processor user interface, or the internal web server.
   d) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
   e) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
   f) A Color picker, supporting Hue, Saturation and Brightness (HSB) color selection shall be available for color selection of color changing fixtures and provide visual feedback of the current color produced by the associated fixture.
      (1) The color picker shall be provided with a default layout that requires no user configuration
      (2) The Color Picker shall provide RGB faders in addition to the default HSB color wheel for color selection
      (3) Color picker values shall allow for numerical value input in addition to color wheel and fader control
      (4) The color picker shall be compatible with color mixing systems that use up to seven discrete color control channels
   g) Virtual Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the Windows-based configuration program.
   h) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.
   i) Optional fader functions include master control, individual channel control, fade rate control or preset master control.

2.4 UNISON ERN SERIES CONTROL ENCLOSURES

A. Control Enclosures
   1. The control enclosure shall be the Unison ERn Series Control Enclosure as manufactured by Electronic Theatre Controls, Inc., or equal.
   2. Mechanical
      a. The External Processing enclosure shall be a surface mounted panel constructed of 18 gauge formed steel panels with a hinged, lockable full-height door containing an integral electrostatic air filter.
         1) The enclosure door shall have an opening to allow limited access to the control module face panel.
         2) Enclosures shall be convection cooled without the use of fans.
      b. Control Enclosures shall be sized to accept one or two Control Processors and one or two Station Power Modules, including various options and accessories.
         1) The Control Enclosure for a single control processor (ERn2) shall support a single Station Power Supply module; The Control Enclosure for 2 control processors (ERn4) shall support a quantity of 2 modules.

c. All enclosure components shall be properly treated and finished.
    1) Exterior surfaces shall be finished in fine textured, scratch resistant, powder based epoxy paint.
d. Enclosure(s) shall also be available in a 19" rack mounted (RM) version.
    1) Rack-mounted version shall have an independent enclosure suspension kit, with a full height, locking door/cover attached to the kit.
    2) Rack-mounted version shall have an opening to access the control module face panel, and openings to view indicators on option modules.
e. Enclosure dimensions and weights (without modules) shall not exceed:
    1) ERn2 - 15" W x 9" H, 10" D, 15 lb
    2) ERn2-RM - 19" W 11"H 10" D, 20 lb.
    3) ERn4 - 15" W x 14" H x 10" D, 20 lb.
    4) ERn4-RM - 19" W x 16" H x 10" D, 25 lb.
f. Top, bottom, and side knockouts shall facilitate conduit entry.
g. Enclosures shall be designed to allow easy insertion and removal of all control and option modules without the use of tools.
    1) Supports shall be provided for precise alignment of modules into power and signal connector blocks.
    2) With modules removed, enclosures shall provide clear front access to all power and control wire terminations.
h. Option Modules
    1) Ethernet Switch
        a) The Control Enclosure shall support an optional 5-port Ethernet Switch, with at least 4 ports supplying Power over Ethernet (PoE).
        b) The Ethernet Switch module shall be 100BaseTX, auto MDI/MDIX, 802.3af PSE compliant.
        c) The Ethernet Switch module shall contain power, status, and activity indicators. All indicators shall be visible when the enclosure door is open for both rack and wall mounted ERn.
    2) Redundant Power Supply (RRPS)
        a) The Control Enclosure shall support an optional redundant power supply which shall automatically provide power to the control electronics upon failure or removal of the primary power supply.
        b) The redundant power supply shall assert itself seamlessly without a loss of power to the control electronics.
        c) The redundant power supply shall seamlessly remove itself when the primary power supply is reengaged.
        d) The redundant power supply shall provide visible indication that it is active.
    3) Station Bus Repeaters (ERn4 only)
        a) The Control Enclosure shall support an optional module to expand the station bus length an additional 400 meters, and the station count an additional 30 stations (60 maximum per processor/enclosure)
        b) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.
    4) Station Bus Dual Repeaters (ERn4 only)
        a) The Control Enclosure shall support an optional module to expand the station bus length to two additional 400 meter segments (a total of 1200 meters from a single enclosure, and the station count to 60 stations (60 maximum per processor/enclosure).
        b) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.
i. Accessories
    1) RideThru Option (RTO) - Required
        a) The Control Enclosure shall support a required, short-term back-up power source for the control electronics.
        b) RideThru Option (RTO) provides power for controls electronics during brief power outages or drop outs.

c) The short-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.
d) The short-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.
e) The short-term back-up power source shall support the control electronics for at least 10 seconds.

2) BatteryPack Option (BPO) - Required
a) The Control Enclosure shall support a required, long-term back-up power source for the control electronics.
b) The long-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.
c) The long-term back-up power source shall supply power to the control electronics for at least 90 minutes.
d) The long-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.
e) A test switch/indicator shall be available without opening the rack door or removal of any modules/components.

j. Electrical
1) External Processing enclosures shall be available in 100, 120, 230 and 240 volt, single-phase configurations.
2) External Processing enclosures shall be completely pre-wired by the manufacturer. The contractor shall provide input and control wiring.
3) External Processing enclosures shall be designed to support the following wire terminations:
a) AC (single phase)
b) Echelon link power (Belden 8471 or equivalent)
c) 24Vdc (2- 16AWG Wire)
d) DMX512A Port A (In or Out) (Belden 9729 or equivalent)
e) DMX512A Port B (In or Out) (Belden 9729 or equivalent)
f) RS232 Serial In/Out (Belden 9729 or equivalent)
g) Unshielded Twisted Pair (UTP) Category 5 Ethernet
h) Contact Closure In (14AWG to 26AWG Wire)
i) Contact Closure Out (14AWG to 26AWG Wire)
(1) Contact Closure Out shall provide 1A @ 30vDC

k. Station Power Modules
1) Station power supply modules shall provide LinkPower for at 32 stations and 1.5A@24VDC of Auxiliary (AUX) power.
2) Station power repeater modules shall provide LinkPower for 30 stations and1.5A@24VDC of Auxiliary (AUX) power.
3) Station power module shall support over-current/short protection for LinkPower and Aux. LinkPower shall support fault detection on each leg of the balanced data bus.
a) All control wire connections shall be terminated via factory provided connectors.

l. Thermal
1) Ambient room temperature: 0-40°C / 32-104°F
2) Ambient humidity: 10-90% non-condensing

2.5 UNISON ERN SERIES CONTROL ENCLOSURES

A. Control Enclosures
1. The control enclosure shall be the Unison ERn Series Control Enclosure as manufactured by Electronic Theatre Controls, Inc., or equal.

2. Mechanical
   a. The External Processing enclosure shall be a surface mounted panel constructed of 18 gauge formed steel panels with a hinged, lockable full-height door containing an integral electrostatic air filter.
      1) The enclosure door shall have an opening to allow limited access to the control module face panel.
      2) Enclosures shall be convection cooled without the use of fans.
   b. Control Enclosures shall be sized to accept one or two Control Processors and one or two Station Power Modules, including various options and accessories.
      1) The Control Enclosure for a single control processor (ERn2) shall support a single Station Power Supply module; The Control Enclosure for 2 control processors (ERn4) shall support a quantity of 2 modules.
   c. All enclosure components shall be properly treated and finished.
      1) Exterior surfaces shall be finished in fine textured, scratch resistant, powder based epoxy paint.
   d. Enclosure(s) shall also be available in a 19" rack mounted (RM) version.
      1) Rack-mounted version shall have an independent enclosure suspension kit, with a full height, locking door/cover attached to the kit.
      2) Rack-mounted version shall have an opening to access the control module face panel, and openings to view indicators on option modules.
   e. Enclosure dimensions and weights (without modules) shall not exceed:
      1) ERn2 - 15" W x 9" H, 10" D, 15 lb
      2) ERn2-RM - 19" W 11"H 10" D, 20 lb.
      3) ERn4 - 15" W x 14" H x 10" D, 20 lb.
      4) ERn4-RM - 19" W x 16" H x 10" D, 25 lb.
   f. Top, bottom, and side knockouts shall facilitate conduit entry.
   g. Enclosures shall be designed to allow easy insertion and removal of all control and option modules without the use of tools.
      1) Supports shall be provided for precise alignment of modules into power and signal connector blocks.
      2) With modules removed, enclosures shall provide clear front access to all power and control wire terminations.
   h. Option Modules
      1) Ethernet Switch
         a) The Control Enclosure shall support an optional 5-port Ethernet Switch, with at least 4 ports supplying Power over Ethernet (PoE).
         b) The Ethernet Switch module shall be 100BaseTX, auto MDI/MDIX, 802.3af PSE compliant.
         c) The Ethernet Switch module shall contain power, status, and activity indicators. All indicators shall be visible when the enclosure door is open for both rack and wall mounted ERn.
   i. Redundant Power Supply (RRPS)
      1) The Control Enclosure shall support an optional redundant power supply which shall automatically provide power to the control electronics upon failure or removal of the primary power supply.
      2) The redundant power supply shall assert itself seamlessly without a loss of power to the control electronics.
      3) The redundant power supply shall seamlessly remove itself when the primary power supply is reengaged.
      4) The redundant power supply shall provide visible indication that it is active.
   j. Station Bus Repeaters (ERn4 only)
      1) The Control Enclosure shall support an optional module to expand the station bus length an additional 400 meters, and the station count an additional 30 stations (60 maximum per processor/enclosure)
      2) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.

k. Station Bus Dual Repeaters (ERn4 only)
    1) The Control Enclosure shall support an optional module to expand the station bus length to two additional 400 meter segments (a total of 1200 meters from a single enclosure, and the station count to 60 stations (60 maximum per processor/enclosure).
    2) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.

B. Accessories
1. RideThru Option (RTO)
    a. The Control Enclosure shall support a required, short-term back-up power source for the control electronics.
    b. RideThru Option (RTO) provides power for controls electronics during brief power outages or drop outs.
    c. The short-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.
    d. The short-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.
    e. The short-term back-up power source shall support the control electronics for at least 10 seconds.

C. Electrical
1. External Processing enclosures shall be available in 100, 120, 230 and 240 volt, single-phase configurations.
2. External Processing enclosures shall be completely pre-wired by the manufacturer. The contractor shall provide input and control wiring.
3. External Processing enclosures shall be designed to support the following wire terminations:
    a. AC (single phase)
    b. Echelon link power (Belden 8471 or equivalent)
    c. 24Vdc (2- 16AWG Wire)
    d. DMX512A Port A (In or Out) (Belden 9729 or equivalent)
    e. DMX512A Port B (In or Out) (Belden 9729 or equivalent)
    f. RS232 Serial In/Out (Belden 9729 or equivalent)
    g. Unshielded Twisted Pair (UTP) Category 5 Ethernet
    h. Contact Closure In (14AWG to 26AWG Wire)
    i. Contact Closure Out (14AWG to 26AWG Wire)
        1) Contact Closure Out shall provide 1A @ 30vDC
4. Station Power Modules
    a. Station power supply modules shall provide LinkPower for at 32 stations and 1.5A@24VDC of Auxiliary (AUX) power.
    b. Station power repeater modules shall provide LinkPower for 30 stations and1.5A@24VDC of Auxiliary (AUX) power.
    c. Station power module shall support over-current/short protection for LinkPower and Aux. LinkPower shall support fault detection on each leg of the balanced data bus.
5. All control wire connections shall be terminated via factory provided connectors.

D. Thermal
1. Ambient room temperature: 0-40°C / 32-104°F
2. Ambient humidity: 10-90% non-condensing

2.6 TOUCHSCREEN CONTROL STATIONS

A. The Touchscreen Control Stations Shall Be The Unison Paradigm Touchscreen P-LCD Series Control Stations As Manufactured By Electronic Theatre Controls, Inc., Or Equal.

B. General
   1. Touchscreen stations shall support default and fully graphical control pages.
   2. The Touchscreen station shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
   3. Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.

C. Mechanical
   1. Touchscreen stations shall consist of a seven inch, backlit liquid crystal display (LCD) with a minimum resolution of 800 by 400 pixels and 12-bit color depth with a touch interface.
   2. Touchscreen bezels shall be constructed of aluminum and shall have no visible means of attachment.
      a. The bezel shall install and remove without the use of tools.
      b. The bezel shall provide two working positions for the Touchscreen: service and operating.
   3. The Touchscreen shall have a protective overlay over the display.
      a. The overlay shall reduce wear
      b. The overlay shall reduce glare
   4. Touchscreens shall offer optional hinged locking covers
      a. Locking covers shall be made from aluminum and be painted to match standard touchscreen color options
      b. Locking covers shall allow for viewing of system status on the touchscreen though a smoked Lexan window
   5. The manufacturer shall provide back boxes for all LCD stations.
      a. Flush back box for Touchscreens with or without locking covers shall be 7.94" wide x 5.33" high x 3.25" deep
      b. Surface back box dimensions shall be 8.3" wide x 5.6" high x 2.75" deep
      c. Surface back box for Touchscreens with locking cover dimensions shall be 10.0" wide x 6.7" high x 2.75" deep

D. Electrical
   1. Touchscreens shall be powered entirely by the System network.
   2. Touchscreens shall connect to the System using an Ethernet network with Power over Ethernet (PoE) or the Unison control station Echelon® Link power network.
      a. Ethernet Network
         1) Ethernet network shall be 10/100BaseTX, auto MDI/MDIX, 802.3af compliant.
         2) Network shall utilize Unshielded Twisted Pair (UTP) Category 5 wiring.
      b. Echelon® Link power network.
         1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
         2) Touchscreen stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
         3) Network wiring may be bus, loop, home run, star or any combination of these.
         4) Network insulation displacement connectors shall be provided with all stations.

E. Functional
   1. System
      a. The Touchscreen shall support configuration firmware upload from a Paradigm Processor as proxy
      b. The Touchscreen shall support configuration or firmware upload from local removable media
   2. Setup Mode
      a. There shall be a setup display that is separate from any user-defined configuration
      b. It shall be possible to view and modify connectivity settings
      c. It shall be possible to view status information
      d. It shall be possible to view and modify LCD screen settings
      e. It shall be possible to perform Touchscreen calibration
      f. It shall be possible to view and modify audio settings
      g. The appearance of the setup display shall be standard and not editable
      h. The setup display may be invoked from within the user-defined configuration and/or physical button on the Touchscreen

i. There shall be a default protected method to invoke the setup display

3. Configurations
   a. It shall be possible to have multiple configurations stored within an LCD Station
   b. Only one configuration may be active on the LCD Station
   c. It shall be possible for Touchscreen Stations connected via the Echelon® Link power network to select a configuration automatically based on the configuration of the physical connection.
   d. Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration
   e. Each configuration shall be identified as a different Station within the System
4. Operation
   a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.
      1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.
         a) Presets shall have a discrete fade time, programmable from zero to 84,600 seconds with a resolution of one hundred milliseconds.
         b) Presets shall be selectable via Touchscreen stations.
      2) System macros and sequences shall be programmable via LightDesigner system software.
         c) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
         d) Macro and sequences shall be activated by button, time clock event or LightDesigner software.
      3) System time clock events shall be programmable via the Touchscreen, LightDesigner system software, the processor user interface, or the internal web server.
         a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
         b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
      4) A Color picker, supporting Hue, Saturation and Brightness (HSB) color selection shall be available for color selection of color changing fixtures and provide visual feedback of the current color produced by the associated fixture.
         a) The color picker shall be provided with a default layout that requires no user configuration
         b) The Color Picker shall provide RGB faders in addition to the default HSB color wheel for color selection
         c) Color picker values shall allow for numerical value input in addition to color wheel and fader control
         d) The color picker shall be compatible with color mixing systems that use up to seven discrete color control channels
   b. Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the Windows-based configuration program.
      1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.
      2) Optional fader functions include master control, individual channel control, fade rate control or preset master control.
   c. Touchscreen stations shall allow programming of station and component electronic lockout levels via LightDesigner.
   d. It shall be possible to adjust LCD contrast and brightness.
   e. It shall be possible to program the station to dim during periods of inactivity.

2.7 INTERFACE STATIONS

A. Stations
   1. Portable Plug-in Stations
      a. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
      b. Mechanical
         1) Unison connector stations shall provide an interface to portable Unison stations.
         2) All connector stations shall be available with white, cream, ivory, gray or black faceplates.
            a) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
         3) All faceplates shall be designed for flush or surface mounting.
         4) Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
         5) Station faceplates shall be indelibly marked with station function.
         6) The manufacturer shall supply back boxes for all surface mounted stations.
   2. Electrical
      a. Unison control station wiring shall be an Echelon® Link power network.
         1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
         2) Portable plug-in stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
         3) Network wiring may be bus, loop, home run, star or any combination of these.
         4) Wiring termination connectors shall be provided with all stations.
      b. Portable Plug-in Stations shall offer the following Regular markings
         1) UL and cUL LISTED
         2) CE Market
         3) RHoS and WEE Compliant
   3. Contact Interface Station
      a. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
      b. General
         1) Unison Contact Interface shall provide direct interface (in and out) to external devices via contact closure. Interface enclosure shall consist of 8 input connections and 8 output connections.
   4. Mechanical
      a. Contact Interface Stations shall be available in enclosures built for:
         1) Wall-mount
         2) Rack-mount
      b. Wall-mount Interfaces shall be:
         1) Designed for surface mount installation
         2) Shall be constructed of 16- gauge (.08) steel and are finished in black fine-texture powder coat paint.
         3) The enclosure shall be 14" W x 10.5" H x 3" D.
         4) Conduit access points shall be provided on the top and bottom of the enclosure.

c. Rack-mount Interfaces shall be:
   1) Designed of use in 19" rack-mount enclosure
   2) Rack tray shall be constructed of 12-gauge aluminum.
   3) Cover shall be constructed of 14- gauge (.08) steel.
   4) Rack-mount interfaces shall be finished in black fine-texture powder coat paint.
   5) The enclosure shall be 14" W x 10.5" H x 3" D.

d. The assembly shall consist of up to 16 connections; 8 inputs functionally coupled with 8 normally open relay contact outputs. Inputs and outputs may be configured as either maintained or momentary.

5. Electrical
   a. Unison control station wiring shall be an Echelon® Link power network.
      1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
      2) Contact Interface stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
      3) Network wiring may be bus, loop, home run, star or any combination of these.
      4) Wiring termination connectors shall be provided with all stations.
   b. Ratings:
      1) The Input Rating shall be 5V@10mA (unit requires dry contact closure)
      2) Dry contact outputs shall consist of:
         a) Normally-Open 2-pole contact closure outputs;
            (1) 1A@30Vdc.
            (2) HYPERLINK "mailto:.5A@120V" 00d0c9ea79f9bace118c8200aa004ba90b0200000003000000e0c9ea79f9bace118c8200aa004ba90b380000006d00610069006c0074006f003a002e00350041004000310032003000560000000795881f43b1d7f48af2c825dc485276300000000a5ab0000.5A@120V
   c. Contact Interface Stations shall offer the following Regular markings
      1) UL and cUL LISTED
      2) CE Market
      3) RHoS and WEE Compliant

B. Fader Interface Station
   1. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
   2. General
      a. Unison Fader Interface shall provide direct interface for low voltage analog inputs to external devices. Interface enclosure shall consist of 8 input connections.
   3. Mechanical
      a. The surface mount enclosure and cover shall be constructed of 16- gauge (.08) steel and finished in black fine-texture powder coat paint.
      b. The enclosure shall be 14" W x 10.5" H x 3" D.
      c. Conduit access points shall be provided on the top and bottom of the unit.
      d. The assembly shall consist of up to 8 analog connections functionally coupled to 8 Lamp driver outputs
   4. Electrical
      a. Unison control station wiring shall be an Echelon® Link power network.
         1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
         2) Touchscreen and Interface stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
         3) Network wiring may be bus, loop, home run, star or any combination of these.
         4) Wiring termination connectors shall be provided with all stations.

b. Ratings:
   1) The Input Rating shall be 0-3.3 VDC
   2) Lamp driver outputs shall be individually rated for 100mA @ 24 VDC
   3) Connections between fader inputs and lamp outputs shall support distances up to 1000 feet using standard 16-gauge wire.
c. Fader Interface Stations shall offer the following Regular markings
   4) UL and cUL LISTED
   5) CE Market
   6) RHoS and WEE Compliant

2.8 BUTTON AND FADER STATIONS

A. Stations
1. Button Stations
   a. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
   b. Mechanical
      1) Unison Heritage Button stations shall operate using up to ten programmable buttons.
      2) All button stations shall be available with white, cream, ivory, gray or black faceplates, and buttons.
         a) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
      3) Stations shall have indicator lights at each button or fader.
         b) Indicators shall be comprised of red, green and blue LED's
         c) Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
      4) All faceplates shall be designed for flush or surface mounting.
      5) Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
      6) Station faceplates shall be indelibly marked for each button or fader function.
      7) The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
      8) All Button stations shall be shall be designed to accept the infrared signal from a remote hand held IR transmitter.
         d) The stations shall have a 60° reception angle and shall operate reliably within a 45' distance.
   c. IR Transmitters shall be available in five or ten button configurations.
      1) IR transmitters shall be mounted in a hand-held black plastic controller.
      2) Transmitter dimensions shall be 1.875" wide, 6.625" long and 0.60" Electrical
      3) Unison control station wiring shall be an Echelon® Link power network.
         a) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
         b) Network wiring may be bus, loop, home run, star or any combination of these.
         c) Wiring termination connectors shall be provided with all stations.
   d. Button Stations shall offer the following Regular markings
      1) UL and cUL LISTED
      2) CE Market
      3) RHoS and WEE Compliant
   e. Functional
      1) The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.
         a) System presets shall be programmable via Button stations, Touchscreen stations, and LightDesigner software.
            (1) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.
            (2) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.

b) System macros and sequences shall be programmable via LightDesigner system software.
(1) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
(2) Macro and sequences shall be activated by button, time clock event or LightDesigner software.
c) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.
(1) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
(2) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

2) Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.
a) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.
b) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

3) Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.

B. Fader Stations
1. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
2. Mechanical
a. Unison Heritage Fader Stations shall operate using up to sixteen programmable faders and twelve programmable buttons.
b. All fader stations shall be available with white, cream, ivory, gray or black faceplates, fader knobs, and buttons.
1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
c. Fader stations shall utilize standard 45-millimeter slide potentiometers.
d. Stations shall have indicators lights at each button or fader.
1) Indicators shall be comprised of red, green and blue LED's
2) Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
e. All faceplates shall be designed for flush or surface mounting.
f. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
g. Station faceplates shall be indelibly marked for each button or fader function.
h. The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
i. Fader stations shall be shall be designed to accept the infrared signal from a remote hand held IR transmitter.
1) The stations shall have a 60° reception angle and shall operate reliably within a 45' distance.

j. IR Transmitters shall be available in five or ten button configurations.
    1) IR transmitters shall be mounted in a hand-held black plastic controller.
    2) Transmitter dimensions shall be 1.875" wide, 6.625" long and 0.60" deep.

3. Electrical
    a. Unison control station wiring shall be an Echelon® Link power network.
        1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
        2) Touchscreen and Interface stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
        3) Network wiring may be bus, loop, home run, star or any combination of these.
        4) Wiring termination connectors shall be provided with all stations.
    b. Fader Stations shall offer the following Regular markings
        1) UL and cUL LISTED
        2) CE Market
        3) RHoS and WEE Compliant
4. Functional
    a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface, or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.
        1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.
            a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.
            b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.
        2) System macros and sequences shall be programmable via LightDesigner system software.
            a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
            b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.
        3) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.
            a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
            b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
    b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.
        1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.
        2) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.
    c. Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.

C. Portable Plug-In Stations
   1. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
   2. Mechanical
      a. Unison connector stations shall provide an interface to portable Unison stations.
      b. All connector stations shall be available with white, cream, ivory, gray or black faceplates.
         1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
      c. All faceplates shall be designed for flush or surface mounting.
      d. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
      e. Station faceplates shall be indelibly marked with station function.
      f. The manufacturer shall supply back boxes for all surface mounted stations.
   3. Electrical
      a. Unison control station wiring shall be an Echelon® Link power network.
         1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
         2) Portable plug-in stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
         3) Network wiring may be bus, loop, home run, star or any combination of these.
         4) Wiring termination connectors shall be provided with all stations.
      b. Portable Plug-in Stations shall offer the following Regular markings
         1) UL and cUL LISTED
         2) CE Market
         3) RHoS and WEE Compliant
   4. Functional
      a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.
         1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.
            a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.
            b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.
         2) System macros and sequences shall be programmable via LightDesigner system software.
            a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
            b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.
         3) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.
            a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
            b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.
    1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.
    2) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

D. Locking Covers
1. The Lighting Control Station Locking Covers shall be the Unison Heritage UH Series as manufactured by Electronic Theatre Controls, Inc., or equal.
2. Mechanical
    a. Locking covers shall be available in Sliding Locking for flush mount applications and Hinged Locking for flush and surface mount applications
    b. Sliding Locking Covers shall
        1) Be available with white, cream, ivory, gray or black faceplates.
        2) Be constructed of Extruded Aluminum with ABS plastic end caps
        3) Provide a smoked Plexiglas window to allow for viewing control status and use of IR remote without opening cover
    c. Hinged locking covers shall:
        1) Be available in standard black powder coat finish
        2) Be constructed of 18 gauge steel and finished in standard black powder coat paint, or custom color as specified.
        3) Provide a clear Plexiglas window to allow for viewing control status and use of IR remote without opening cover
        4) Use internal Hinge that is not accessible when the cover is closed
    d. Standard colors shall conform to the RAL CLASSIC Standard.
    e. Locking covers of the same type shall be keyed alike
    f. The manufacturer shall supply back boxes for all hinged locking covers
3. Functional
    a. All locking covers shall utilize 90-degree locking mechanisms
        1) Keys shall be held captive in locks when covers are unlocked.
    b. Locking covers shall allow for easy viewing of system status without opening the cover
    c. Locking covers shall support IR remote activation of configured system functions without opening door

2.9 LIGHTING SYSTEM AND ACCESSORIES

A. General
1. The lighting control desk shall be a microprocessor-based system specifically designed to provide complete control of stage, studio, and entertainment lighting systems. The device shall be the Ion as manufactured by Electronic Theatre Controls, Inc., or equal.
2. The system shall provide control of 1024 outputs, 1536 outputs, 2048 outputs, 2560 outputs or 3072 outputs on a maximum of 10,000 control channels, patched across any number up to 99,999. Output shall be distributed over a 10/100MB Ethernet network using Net3/ACN, ETCNet 2, Avab and/or ArtNet protocols. The user shall be able to control the application of protocols at an individual address level.
3. The system shall support full bi-directional RDM communication with compatible devices via Net3 DMX/RDM Gateways. RDM communication shall adhere to ANSII standard E1.20-2006 Entertainment Technology – RDM – Remote Device Management Over DMX512 Networks. Supported RDM features shall include:
        a) Discovery and identification of RDM capable devices
        b) Setting of start addresses, operating modes and additional settings as exposed by connected devices and controllable via RDM
        c) Viewing of Sensor data as provided by connected devices.
        d) Error reported as provided by connected devices.
4. A maximum of 10,000 cues, 999 cue lists, 1000 groups, 1000 presets, 4 x 1000 palettes (Intensity, Focus, Color and Beam), 1000 effects, 1000 macros and 100 curves may be contained in non-volatile electronic memory and stored to an onboard hard drive or to any USB storage device.

5. Recorded cue lists may be played back simultaneously on a maximum of 200 faders. Channels shall respond to cue information by last instruction with discrete rate control provided for all cues. The desk may be placed in Tracking or Cue Only mode by the user as a system default and overridden on individual record actions as required. HTP/LTP intensity flags, assert, proportional, intensity master or manual master fade control and independent status may be placed on each cue list. It shall also be possible for a cue list to contribute to playback background states or to withhold such contributions.
6. A Master Playback fader pair and dedicated Grand Master/Blackout shall be provided.
7. Up to six USB fader wings may be connected to the desk, for a maximum of 300 submasters and/or 200 playback faders. USB fader wings may be rigidly connected to the main desk to provide a "single connected unit" with no external cables required. The wings also may be connected via USB cables and used "on the side." Virtual fader control is also provided.
8. A high-resolution level wheel shall be provided to control intensity for selected channels and scrolling within selected displays. Four page-able high-resolution encoders shall be provided for control of non-intensity parameters. Non-intensity encoders may be operated in coarse or fine mode, with the amount of movement per revolution of the encoders in coarse mode definable by the user. Non-intensity parameters shall be controllable via the encoders or keypad controls, without need of an external pointing device. A high-resolution rate wheel shall also be provided.
9. Rotary encoders for non-intensity parameters shall be labeled by means of an integral LCD display mounted below the encoders on the main desk. The display shall show the currently loaded functions of the encoders based on the current selections. Systems using encoders with no LCD labeling shall not be acceptable.
10. Control and programming features for automated fixtures shall also include: a standard library of fixture profiles, the ability to copy and edit existing profiles and create new profiles, patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color mixing and storing in Hue and Saturation or native device values.
11. System information, including playback status, live output and blind values for all record targets shall be displayed on a maximum of two external high resolution DVI monitors, or one SVGA monitor, which may also be touch-screen(s). Only one display shall be required for operation.
12. A context sensitive on-line Help feature shall explain and provide an example of the operation of each feature of the system.
13. A fully integrated Virtual Media Server feature shall allow the user to map images and animations to a rig array. 40 such maps may be created, each with 12 layers. Systems that rely on external hardware or software for this functionality shall not be acceptable.
14. User-definable, interactive displays may be created. These displays, which can be used in live and blind operating modes, allow graphical layout of channels, desk buttons and programming tools. Standard symbols are provided, and the user may import his own symbols or graphics. Each symbol may be individually defined with data feedback characteristics. Non-interactive status information, such as a mirror of other user' s command lines, may also be included in the display. A graphical browser is provided for fast selection of these views. Multiple zoom factors and placements may be stored and recalled for each display.
15. An optional, full-functioning, detachable alphanumeric keyboard shall be supported. The keyboard shall allow labeling of channels, cues, presets, groups, palettes, effects, macros, curves and the show. An integral electronic keyboard shall be provided.
16. A row of softkeys shall be provided, which change function based on the selection and context of the desk. These softkeys shall be labeled via an adjacent LCD display that shows their current functions at all times. Systems using softkeys with no LCD display shall not be acceptable.
17. Software upgrades shall be made by the user via a USB port; changing internal components shall not be required. It shall be possible to install software updates in all consoles, processor units and remotes from one device over the network.
18. The operating software shall be loaded into program execution memory from the internal hard drive when the console is powered. In the event of an uncontrolled shutdown, the device shall return to its last output state when power is restored.
19. Dimmer monitoring and configuration features shall be provided (in conjunction with ETC' s Sensor+, Sensor 3 or FDX dimming systems) to allow indication of dimming system status, dimmer load monitoring and show specific configurations.

20. Show data may be created and modified on a personal computer, using either Windows XP or Windows 7 operating systems, with a free offline editing application. The offline editor may also run natively on Intel-based Macintosh platforms using OS X. The program shall also allow output to visualization software supporting the same protocols as the lighting system.
21. A PC using Windows XP or Windows 7/8 or an Intel-based Macintosh computer using OS X running a client software application shall be able to connect to a control system via the network and view or modify current show data in an independent display environment, using an Eos Family Client Dongle. When connected without the dongle, the computer shall operate in Mirror Mode, with the device to be mirrored selectable by the user. Systems that do not provide client software that may run natively on the Apple platform in this environment shall not be acceptable
22. Synchronized backup shall be provided via another full desk on the network or by use of a remote processor unit. The backup unit (either full desk or rack mounted Remote Processor Unit (RPU) shall maintain synchronized playback with the master and shall take over control of the lighting system upon loss of communication with the master. Use of two RPUs to service and backup system output is also supported. Systems that do not offer this kind of instant backup from multiple sources shall not be acceptable.
23. A maximum of four users may access and interact with show data simultaneously. Each user shall have an individual workspace and channel partitioning shall be supported. User identification may be assigned to more than one control device, allowing users to work in tandem, or allowing a designer/ALD to mirror the current display format, mode and command line of the associated programmer. Partitioned control allows discrete control of channel/parameter groupings by user. Partitioned control may be easily enabled and disabled with no need to merge show data from multiple users.
24. Mirror mode shall allow the desk displays and operating modes to be mimicked on another connected device. Alternatively, the desk may mirror another device.
25. The system shall allow remote control from external devices as follows: Client software running on a PC connected to the network, a remote video interface with keyboard, a purpose-built wireless remote focus unit (Radio Focus Remote). Universal fader wings may be attached to any of these devices for local fader control. Systems without these remote control devices shall not be acceptable.
26. The system shall support a Telephone remote control that allows basic functions to be controlled from a standard wireless phone producing touch-tone signals. This allows the use of a standard telephone for a low cost remote control. Systems that do not allow this function shall not be acceptable.
27. Show data may be created and modified on a personal computer, using either Windows XP or Windows 7/8 operating systems, with a free offline editing application. The offline editor may also run natively on Intel-based Macintosh platforms using OS X. The program shall also allow output to visualization software supporting the same protocols as the lighting system.
28. The system shall support up to 32 individual Time Code Event lists.

B. Controls And Playback
   1. Manual Control and Programming Section
      a. The programming keyboard shall be grouped by function. Major groupings shall be record target functions, numeric keys, level assignment functions, display navigation functions and controls.
      b. Non-intensity parameters may be set numerically or via the encoders. This control shall be fully interactive. In either case the current parameter value shall be displayed on the desk monitor and simultaneously on the integral LCD display. Systems using only a local LCD or only a video monitor shall not be acceptable.
      c. Only those parameters available for control in the active lighting system shall be displayed for control.
      d. Lamp controls provide direct access to luminaire functions such as striking and dousing arc lamps and calibrating entire fixtures or individual mechanisms of fixtures, as provided by the luminaire manufacturer. User access to these features is normalized across all manufacturers for ease of use. Use of a "control channel" for accessing these functions shall not be required and systems requiring use of a control channel shall not be acceptable. Lamp control commands maybe e staged, and channels which have been sent lamp on commands so indicated in live.
      e. Fan functions shall be provided both via command line operation and through encoder controls.
      f. Highlight shall be supported, with user definable highlight values. Lowlight conditions may be defined for selected, but not specified channels. Rem Dim command, at specific levels by channel, may be optionally and automatically called with the highlight command.
      g. Fixtures with CMY or RBG color mixing may be set with direct CMY or RBG controls, as well as the Hue and Saturation encoders and/or color picker. Color may also be set directly to a gel match, via a graphic selection tool or from the command line.
      h. The Virtual Media Server function shall allow the user to create layouts of devices, identified as pixel maps. Media content (images, movies, text and procedurally generated effects) may then be applied, manipulated and stored. Stock content is provided and the user may import custom imagery and animations.
      i. Macros may be set to run as default. Default macros called manually shall post to the command line, but executed via cue lists shall run in the background. The user may override this behavior by defining the macro to always execute in the foreground or the background, regardless of the recall method. Startup, Shutdown and Disconnect macros may also be defined.
   2. Playback Section
      a. The master fader shall consist of a 60mm Master Fader pair with associated Load, Go and Stop/Back buttons. Additional playback faders may be configured via the virtual fader module or on the Universal Fader Wings.
      b. It shall be possible to instantaneously halt an active cue, back to the previous cue, manually override the intensity fade or manually override the entire fade.
      c. It shall be possible for a cue list to contribute to the background state or for the contents of each cue list to be withheld from such.
      d. The playback faders shall have the following associate controls:
         1) Freeze, which halts the output of the fader
         2) Stop Effect, which stops the action of an effect.
         3) Filter, to assign filter states to a fader
         4) Go to Cue 0, to reset a cue list.
   3. Fader Wings (Optional)
      a. Submaster and fader support shall be provided via optional fader wings. These wings are available in 1x20, 2x10 and 2x20 configurations. Up to six of these wings may be connected to the desk via internal or external USB. Via paging, access is provided to all 300 faders, regardless of the number of physical wings attached.
      b. The 2x10 and 2x20 fader wings shall include a full length LCD for labeling and identification functions. Each fader shall have two associated hard buttons for various operations. Systems without a local display or fewer than two buttons per fader shall not be acceptable.
      c. Up to 300 proportional, fully overlapping additive, effect or inhibitive submasters may be defined. Submasters shall have colored LEDs to indicate submaster status. Each submaster may have fade up, dwell and down fade times. Each has a bump and assert/channel select button. Submasters may be set to independent, exclusive, shielded and proportional/intensity or effect master control.

d. The submaster blind buffer shall be linked directly to live playback allowing live editing of live submaster content via the command line.
e. It shall be possible to set submaster values directly from the command line.
f. Up to 200 cue lists may be active concurrently.

4. Grand Master
   a. A dedicated grand master and blackout button are provided.
   b. The grand master shall proportionally fade intensity values to zero. Blackout shall send all intensity outputs to zero. Non-intensity outputs shall not be affected. No additional configuration shall be required to withhold non-intensity values from Grand Master and Blackout control.

C. Display Controls
1. Format shall change the view of selected displays.
2. It shall be possible for the user to choose which parameter categories or parameters (s)he wishes to display.
3. Flexichannel shall change which channels are viewed in selected displays, as follows:
   a. All channels
   b. Patched channels
   c. Show channels
   d. Active/Moved channels
   e. Selected channels
   f. Manual Channels
   g. View channels (user identified list)
   h. Channels with discrete timing
4. Expand shall extend the selected view sequentially across connected displays, vertically or horizontally
5. [Time] depressed shall display discrete timing data. [Data] depressed shall display absolute values of referenced data.
6. User definable magic sheets shall provide alternative display of and access to channels and record targets. Multiple magic sheets may be created.
7. Playback status displays are provided with a variety of different formats. Indications are provided per cue for live moves (lights fading from zero and also moving non-intensity parameters) and dark moves (inactive lights which have stored non-intensity parameter moves).

D. Operating Modes
1. Live Mode
   a. Channel lists may be constructed using the +, - and Thru keys as well as the direct selects. Channel selection and deselection is fully interactive, regardless of the method used.
   b. Levels may be set with the keypad, level wheel and non-intensity encoders. "Selected" channels shall be those last addressed and under keypad control.
   c. Sneak shall be used to restore specified channels to background states, default values, or to send them to specified values, in user specified or default times.
   d. Selected channels may be set at a level or held to current values while all other channels are set to zero using Rem Dim. Toggling Rem Dim shall restore all unselected channels to original levels. The Rem Dim level shall be user definable via the command line or with a default setup value.
   e. Channels may be recorded into groups for fast recall of commonly used channels. 1000 groups shall be available. Groups shall store selection order. The Offset function supports rapid creation of ordered groups, including reverse and random order.
   f. Parameter settings may be stored to Intensity, Focus, Color and Beam Palettes and to Presets. All referenced data may be stored to whole numbers or to up to 99 decimal places between each whole number. It shall be possible to store 1000 presets and 1000 of each palette type.
   g. Any collection of channel data, as determined by the use of "Record", "Record Only, selective store commands and/or parameter filters may be stored to palettes (as appropriate to the type) and presets.
   h. The following conditions may be placed on a channel or channel parameter to be included with a cue record action.
      1) Discrete fade time and/or delay
      2) Block flag
      3) Assert flag

4) IFCB Filters, which may be set at a parameter level.

i. 999 cue lists may be stored. Cues may be recorded in any order. Up to 99 decimal cues may be inserted between any two whole number cues. Each cue may contain a maximum of twenty parts. Parameters may be automatically assigned to specific parts or assigned when the part is created.

j. It shall be possible to record cues and cue parts with the following information:
   1) Any collection of channel data, as determined by the use of "Record", "Record Only" or selective store commands, combined with parameter filters.
   2) Cue Level timing and delays for Intensity Up, Intensity Down, Focus, Color and Beam.
   3) Follow or hang time
   4) Link instruction
   5) Loop value
   6) Block, Assert, Allfade, Preheat and/or Mark Flag
   7) Curve
   8) Label and note
   9) Execute list to trigger other activity

k. Non-intensity channel parameters may be marked (preset), in two ways. Automark presets any parameters transitions in the cue just prior to intensity becoming active. Automark may be disabled on a cue or cue part basis, enabling a "live" move. Alternatively, non-intensity parameters may be marked to a specific cue with a single command instruction. It shall not be necessary to store these parameters directly into the cue in which the movement is to occur.

l. Any channel parameter may be stored with an effect instruction. These effects may contain relative offsets from current value, or absolute instructions. Effects may be progressive action or on/off states. Entry and exit behaviors shall modify the channel parameters activity when beginning and ending the effect.

m. Update may be used to selectively add modified parameter data quickly to that parameter's current source. It shall be possible to update inactive record targets. It shall also be possible to update back to the current source of the move instruction without specifying that cue via Trace. A context sensitive display provides detailed information regarding the results of the update command.

n. Recall From quickly pulls specified data from record targets or other channels into the current view. Recall from on an HTP basis shall be provided.

o. Copy To quickly copies selected data to specified channels or other record targets.

p. Address and channel check functions shall be provided.

q. Channel parameters may be "parked" at levels. Output addresses may also be parted directly. Parked levels shall not be added to any live record operations, nor may they be changed until the parked element is "unparked". Address Park shall also be provided.

r. About shall provide detailed status of selected channels or specified record targets. This shall include current source, current value, discrete timing, parked value, marked to and for indications. Background levels and current DMX output are also displayed. Channel usage indicates submaster and cue information and also provides a "dark moves" report on a per channel basis

s. 1000 snapshots may be stored which instantly recall specified front panel and display configurations.

t. Live data may be displayed in a summary view, detailed table orientation or a user-defined magic sheet

u. Undo shall be used to sequentially step back through manual operations, record, update and delete actions. Redo functions shall be provided. Multiple undo commands may be executed at once.

v. Home shall set selected channels non-intensity parameters to their default values. User definable home, on a per- channel/per- parameter basis shall be provided.

w. Move shall allow all show data to be moved from one record target to another.

x. Query shall allow selection of channels by their current or possible state. Keywords and fixture types shall allow quick access to fixtures.

2. Blind

   a. The Blind display allows viewing and modification of all record targets without affecting stage levels.

b. Record target data may be displayed in a summary view, a detailed table orientation or a spreadsheet view, which allows quick data comparisons, move and replace with functions.
c. Changes made in blind displays shall be automatically stored.
d. Blind editing shall be possible for all record targets.
e. Selection of what parameter data to view for blind editing shall be user configurable.

3. Patch Display
   a. Patch shall be used to display and modify the system control channels with their associated library data.
   b. Each channel may be provided with a proportional patch level, preheat, curve, label, swap and invert functions.
   c. Offset functions in patch shall allow selection of channel ranges and shall allow the user to establish a "custom" footprint for any device output.
   d. A full library of profiles is provided, with the ability for the user to define "favorites" for fast selection.
   e. Custom color wheels, color scrolls and gobo wheels shall be defined in patch. These devices shall be created with a simple table and graphical user interface supported by images of major manufacturers.
   f. Copy to and Move functions shall be supported in patch.
   g. RDM discovery and device monitoring shall be supported.
4. Setup/Browser
   a. Setup shall access system, show and desk configurations.
   b. The browser shall access show data storage, import, export, print to .pdf and clear functions, as well as show data utilities.
   c. It shall be possible to partially merge show files. Users shall be able to select as much or as little of the show file as required, with renumber tools.
   d. It shall be possible to import ASCII and Lightwright data files. It shall be possible to export as ASCII or .csv.

E. Dimmer Monitoring And Configuration
1. The lighting control system shall provide communication with an ETC Sensor+, Sensor3 or FDX dimming system for remote monitoring and configuration of show specific functions from within the software application.
2. Circuit level configuration and monitoring functions shall include but not be limited to:
   a. Control mode (dimmable, switched, latch-lock, always on, off or fluorescent).
   b. Curves
   c. Control threshold
   d. Min and Max Scale Voltage
   e. Preheat
   f. Scale load
3. Rack Status messages shall include but not be limited to:
   a. State of UL924 panic closure
   b. DMX port error/failure
   c. Network error/failure
   d. A, B, C Phase below 90 or above 139 volts and headroom warning
   e. Ambient temperatures out of range
4. Circuit status shall include but not be limited to:
   a. Module type and location
   b. Output level
   c. Control Source
   d. Overtemp
5. Advanced circuit feedback shall include but not be limited to:
   a. Load higher or lower than recorded value
   b. DC detected on output
   c. SCR failed on/off
   d. Breaker trip
   e. Module has been removed
   f. Load failure
   g. Shutdown due to Overtemp

F. Training Options
   1. Training packages shall be available customizable to the individual venue preferences and needs. The level of training (beginner, intermediate or advanced) may be selected and training may be defined as an element of system commissioning or deferred to a later time.

G. Interface Options
   1. The unit shall support a variety of local interfaces.
      a. AC input.
      b. USB (five ports for connecting devices such as an alphanumeric keyboard, mouse, touch screens, USB Flash drive, fader wings, etc.) The desk shall provide four ports on the rear of the unit and one on the control service itself.
      c. Ethernet (one port) 802.3af compliant
      d. Two DVI video output connectors, supporting a maximum of two DVI monitors at 1280x1024 resolution minimum.
      e. One VGA output connector.
      f. Up to six fader wings may be attached to the main console via internal or external USB connections. Systems that do not allow the addition of fader wings shall not be acceptable.
      g. Two DMX512-A/RDM Ports
      h. Contact Closure Trigger via D-Sub Connector
      i. Phone Remote
      j. MIDI In/Out (MIDI Timecode, MIDI Show Control)

H. Accessories
   1. Net3 Radio Focus Remote
   2. iRFR and iRFR Preview (application for iPhone, iPod Touch and iPad units)
   3. aRFR (application for Android devices)
   4. Net3 Remote Video Interface
   5. 1 x 20, 2x10 and 2x20 Universal Fader Wings
   6. Net 3Gateways
      a. Net3/ETCNet 2 to DMX/RDM Gateways (one to four ports)
      b. MIDI/SMPTE Gateways
      c. I/O Gateway with 12 analog inputs, 12 SPDT contact outputs, RD232 interface
   7. Eos Family Client Software Kit

I. Synchronized Backup
   1. An optional Backup system shall consist of one of the following combinations of devices:
      a. Two networked desk
      b. One (or more) desk with one Remote Processor Unit (RPU)
      c. One (or more) desk with two Remote Processor Units (RPUs)

J. Physical And Acoustical
   1. All operator controls and electronics for a standard system shall be housed in a single desktop console, not to exceed 19" wide, 19" deep, 5.5" high, weighing 20 pounds.
   2. Power shall be 95 – 240V AC at 50 or 60Hz, supplied via a detachable power cord.
   3. At typical CPU utilization, the unit shall operate at 26 dBA.

2.10 REMOTE PROCESSOR UNIT

A. General
   1. The remote processor unit (RPU) shall be a microprocessor-based system specifically designed to provide complete control of stage, studio and entertainment dimming systems. The RPU shall be the Ion Remote Processor Unit as manufactured by Electronic Theatre Controls, Inc., or equal.
   2. The system shall provide control of (2048 or 3072) parameters on a maximum of 10,000 control channels, patched across any number up to 99,999. Output shall be distributed over a 10/100MB Ethernet network using Net3/ACN, ETCNet 2, Avab and/or ArtNet protocols. The user shall be able to control the application of protocols at an individual address level.
   3. The Remote Processor Unit shall be functional as the primary or backup processor for a full system or as a stand-alone lighting playback controller and shall support all operating functions and interface capacities of the application software (Ion or Gio) it is running
   4. A maximum of 10,000 cues, 1000 groups, 1000 presets, 4 x 1000 palettes (Intensity, Focus, Color and Beam), 1000 macros, 100 curves, 999 cue lists and 300 submasters (additive, effect or inhibitive) may be contained in non-volatile electronic memory and stored to an onboard hard disk or to any USB storage device.
   5. The data processing program shall be in internal non-volatile read only memory. The system shall not require the use of any peripheral storage/retrieval equipment to function. Such devices shall be for library storage only. Persistent storage shall protect the show data from an unintentional power loss. Personal computers running emulation programs shall not be acceptable.
   6. Software updates shall be installed locally via USB flash drives or remotely across the network from another system device.
   7. 20 pre-programmed buttons, which may be remapped to any desk keys, shall be provided on the front panel of the RPU.
   8. The unit shall support two external DVI high-resolution monitors (1280x1024 minimum resolution), which may also be touchscreens.
   9. A variety of different controls may be attached to the RPU via the USB ports on the back or front of the device, including an alphanumeric keyboard, pointing devices, Universal Fader Wing, or special purpose keyboards (by others).
   10. Integrated dimmer monitoring features shall be provided to allow indication of dimming system status, error states and dimmer load monitoring. Adjustment of dimmer configuration shall also be supported. Communications with the dimming system shall utilize ANSI E1.17 2006 - Entertainment Technology - Architecture for Control Networks.
   11. Integrated RDM device features shall be provided. The device shall discover and patch RDM device. The device shall monitor RDM devices to allow indication of RDM device online/offline status error states. The device shall be capable of changing settings of RDM devices such as changing the DMX start address. Communications with the RDM devices shall utilize ANSI E1.20 2006 – Remote Device Management.
   12. The operating software shall be loaded into program execution memory from the internal hard drive when the device is powered. In the event of an uncontrolled shutdown, the device shall return to its last output state when power is restored.

13. The Remote Processor Unit may be installed for Lighting Playback applications and/or may be part of a synchronized backup system. The RPU may be configured as either a primary or backup unit. The backup desk/RPU shall maintain synchronized playback with the primary and shall take over control of the lighting system upon loss of communication with the primary. Transfer of control may be automatic and upon user prompt. Use of two RPUs to service and backup system output is also supported
14. A maximum of four users may access and interact with show data simultaneously. Each user shall have an individual workspace. User identification may be assigned to more than one control device, allowing users to work in tandem, or allowing a designer/ALD to mirror the current display format, mode and command line of the associated programmer. Partitioned control allows discrete control of channel/parameter groupings by user. Partitioned control may be easily enabled and disabled with no need to merge show data from multiple users.
15. LED Indicators shall be provided to indicate role and current status of the device. Roles shall include Primary and Backup. Status indicators shall include Tracking and Master.
16. Systems that do not provide the above capabilities shall not be acceptable.

B. Operating Modes
   1. The Remote Processor Unit shall support all of the features and functions of the application software.
   2. The Remote Processor Unit may function in one of three ways:
      a. As an independent user on the network
      b. As the same user as another device on the network
      c. In mirror mode, mimicking the displays of a designated user on the network

C. Interfaces
   1. The Remote Processor Unit shall support a variety of local interfaces.
      a. AC input
      b. USB (six ports for items such as alphanumeric keyboard, pointing devices, touch screens, USB Flash drive, etc.)
      c. Ethernet (one port) 802.3af compliant
      d. Two DVI video output connectors at 1280x1024 resolution minimum
      e. One SVGA video output connector.
      f. Midi In/Out
      g. Contact Closure triggers via D-Sub connector
      h. DMX512-A/RDM outputs (two connectors)

D. Accessories
   1. Net 3 RFR (Radio Focus Remote)
   2. iRFR (application for iPhone, iPod Touch and iPad Units)
   3. aRFR (application for Android devices)
   4. Net3 RVI (Remote Video Interface)
   5. Universal Fader Wings - up to six shall be supported by the device.
   6. Gateways
      a. Net3/ETCNet 2 to DMX/RDM Gateways (one to four ports)
      b. Show Control Gateway (MIDI In/Out, SMPTE In)
      c. I/O Gateway (12 analog inputs, 12 SPDT contact outputs, RS-232 interface)

E. Physical
   1. All controls and electronics shall be in a single enclosure, not to exceed 17.13" (435mm) wide, 15.88" (403mm) deep, 3.52" (89mm) high, weighing 22.5 pounds (10,21 kg). Power shall be 90 – 240V AC at 50 or 60Hz, supplied via a detachable power cord.

2.11 DATA PLUG-IN STATIONS

A. General
   1. The Plug-in Stations shall consist of the appropriate connectors required for the functional intent of the system. These stations shall be available with DMX input or output, Remote Focus Unit, Network, or architectural control connectors. Custom control connectors shall be available.

B. Connector Options
   1. The following standard components shall be available for Plug-in Stations:
      a. 5-Pin male XLR connectors for DMX input

b. 5-Pin female XLR connectors for DMX output
c. 6-Pin female XLR connectors for RFU and ETCLink connections
d. RJ45 connectors for Network connections - Twisted Pair
e. 6-Pin female DIN connectors for Unison connections
f. DB9 female serial connector for architectural control from a computer

2. Custom combinations and custom control connections shall be available.

C. Physical
1. Station faceplates shall be .80" aluminum, finished in fine texture, scratch-resistant black powder coat. Silk-screened graphics shall be white.
2. The station panel shall mount into an industry standard back box, depending on size and quantity of connectors. A terminal block shall be supplied for contractor terminations.

2.12 WALL MOUNTRELAYPANEL

A. General
1. The wall mount relay panel shall be the Unison Echo Relay Panel as manufactured by Electronic Theatre Controls, Inc., or equal. Unison Echo Relay Panels shall be UL508, UL67, and UL924 Listed, and shall be so labeled when delivered.
2. The Unison Echo Relay Panel shall consist of a main enclosure with 30 pole breaker subpanel, Relay sub panel, integral control electronics, and a low voltage subpanel for data terminations and provision for up to three accessory cards

B. Mechanical
1. It shall be constructed of 16-gauge steel. All panel components shall be properly treated, primed and finished in fine-textured, scratch resistant paint.
2. The 120V enclosure shall be 67.5" high by 14.36" wide and 4" deep and weigh no more than 80 pounds. The 277V panel shall be 67.5" high by 20" wide and 6" deep and weigh no more than 130 pounds.
3. The enclosure shall be capable of being mounted on the surface of a wall or recessed between standard width (16" on center) wall studs
4. Choice of outer panels shall be available for flush or recess mount applications. This outer panel shall ship complete with a locking door to limit access to electronics, breakers, and local relay overrides
a. Optional center-pin reject security screws shall be available for all accessible screws.
b. Flush mount door shall extend 1" beyond all panel edges to hide wall cut-out
5. The unit shall provide interior cover to allow access only to class 2 wiring and prevent direct access to touch live components breakers and relays.
6. Relay subpanel may include up to twenty-four 20 amp single pole, up to twelve 20 amp double pole, or eight three pole relays as required in any combination up to capacity.
7. Relay override panel shall provide 24 button overrides which allow the user to directly change the state of any or all relays at the panel.
a. Relay overrides shall be available for each relay which indicate current state of the relay by way of LED indicator
b. Numerical circuit number reference which matches the relay to its breaker
c. Removable load schedule label shall be provided which allows the customer to name each of the relay circuits
8. Relay output lugs shall accept 6-14AWG copper wire
9. Breaker subpanel may include up to twenty-four 20 amp single pole, up to twelve 20 amp double pole, or eight three pole breakers as required in any combination up to capacity
10. The control wiring shall land on a removable header for easy contractor installation (On-board DMX, station, and Emergency Input terminations).

C. User Interface
1. The user interface shall contain a graphical display with button pad to include 0-9 number entry, up, down back arrow navigation and enter.
2. Test shortcut button shall be available for local activation of preset, sequence and set level overrides.
3. The user interface shall have a power status LED indicator (Blue), a DMX status LED indicator (Green), a network status LED indicator (Green) and an LED indicator (red) for errors.

4. USB memory stick interface for uploads of setup and software updates

D. Functional
1. Pack setup shall be user programmable. The control panel shall provide the following relay setup features (per circuit):
   a. Type (1 pole, 2 pole, or 3 pole)
   b. Name
   c. Circuit
   d. DMX address
   e. sACN address
   f. Space
   g. Circuit Mode
      1) Normal (priority and HTP based activation)
      2) Latch-lock
      3) Fluorescent
      4) DALI
   h. "On" threshold level
   i. "Off" threshold level
   j. Include in UL924 emergency activation
   k. Allow Manual
2. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay period of 0.1 to 60 seconds, in 0.1 second increments, per relay.
3. Control electronics shall report the following information per branch circuit:
   a. Breaker state
   b. Relay state
   c. Current draw
   d. Voltage
   e. Energy usage over time
4. Built in Control shall include:
   a. From the control panel or optional button stations, it shall be possible to record up to 16 presets per space for up to 8 spaces per panel.
   b. Presets shall be programmable by recording current levels (as set by DMX), by entering levels on the face panel directly, manually selecting relay state on each relay, or a combination of both methods.
   c. Indication of an active preset shall be visible on the LCD display.
   d. Two 16-step sequences for power up and power down routines
   e. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting relays to "on", while setting non-emergency relays "off". Each relay can be selected for activation upon contact input.
   f. Data lose behavior
5. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad. Any switch may be patched to any DMX channel.
   a. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.
   b. The relays shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz.
   c. Setting changes shall be able to be made across all, some, or just one selected relay in a single action from the face panel
   d. Rack
      1) Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address.
      2) Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting.
6. Architectural Setup
   a. DMX loss behavior
   b. DMX priority
   c. Station power (on/off)

d. Preset priority
e. Backlight timeout and shutoff mode
f. Contrast
g. Language
h. Spaces
i. Network settings

E. Electrical
1. Modules available to support:
a. ERP 120/208V three phase 4-wire plus ground
b. ERP-2 120/240V single phase 3-wire plus ground
c. ERPA 277/480V, 230/400V and 240/415V three phase. 4-wire plus ground
2. The individual relays shall be mechanically latching
3. The relay shall be capable of switching 20A at up to 300V.
4. Max Feed size: 200 amp
5. Main circuit breaker options:
a. Main breaker shall be optionally available for purchase.
b. Main breaker shall be field installable
c. Main breakers options: 100 (150 amp at 277V) amp or 200 amp

OPERATING VOLTAGE	MCB OPTION	SCCR RATING	INPUT LUG WIRE SIZING
120/240V	100A,200A	22kA	1AWG – 300kcmil
120/208V	100A, 200A	10kA	3/0 – 300kcmil
- -	200A	10kA	- -
277/480V	150A,200A	14kA	6AWG – 350kcmil
- -	200A	65kA	6AWG – 350kcmil
Ground Bar	NA	NA	14AWG – 2/0

F. Relay
1. Each relay shall have a manual override switch with on/off status indication.
2. 20A 277V Ballast (HID)
3. 16A Electronic Ballast up to 277V
4. 20A Tungsten up to 277V
5. 20FLA @ 120V Motor Load
6. 17 FLA @ 240V Motor Load
7. 14 FLA @ 277V Motor Load
8. Isolation: 4000V RMS
9. State: Latching
10. Life:
a. 100,000 cycles at full resistive load
b. 30,000 cycles motor, inductive, or tungsten
11. Current reporting accuracy: 5%

G. Sccr
1. System SCCR rating shall be a minimum of 10kA at 120V and 14kA at 277V when fitted with main lugs

2. System SCCR ratings shall be rated at:

OPERATING VOLTAGE	MCB OPTION	SCCR RATING
120/240V	None	10kA
- -	100A, 200A	22kA
120/208V	None, 100A, 200A	10kA
- -	200A	22kA, 42kA
277/480V	None, 150A, 200A	14kA
- -	200A	65kA

H. Accessories
1. The following accessories shall be optionally available:
   a. Network Interface
   b. Low voltage 0-10V Dimming Control
   c. Ride-Thru Option
   d. Main Breakers as shown in Section G.2

I. Thermal
1. The panel shall be convection cooled.
2. The panel shall operate safely in an environment having an ambient temperature between 32°F (0°C) and 104°F (40°C), and humidity between 5-95% (non-condensing).

2.13 EMERGENCY BYPASS DETECTION KIT (EBDK)

A. Emergency Bypass Detection
1. Where required to detect the loss of normal power and trigger special-purpose lighting presets, the detection means shall be the Emergency Bypass Detection Kit as manufactured by Electronic Theatre Controls, Inc., or equal.
2. Mechanical
   a. The Kit Enclosure shall be a surface mounted, constructed of 16-gauge, formed steel panels with a removable front cover.
   b. The Emergency Bypass Detection Kit shall include a 3-pole, 10 amp breaker for local over-current protection and simulation of normal power loss.
      1) The enclosure shall have a lockable door to allow limited access to the over-current protection breaker
   c. All components shall be properly treated and finished.
      1) Exterior surfaces shall be finished in fine textured, scratch-resistant, powder coat paint
   d. The EBDK enclosure shall provide discrete high and low voltage wiring compartments with voltage barrier.
   e. EBDK dimensions and weights shall not exceed:
      1) 10.5" H x 14" W x 4.2" D 11 lb.
   f. Accessories
      1) Emergency Bypass Detection Tap Kit (EBDK-TAP)
         a) The Emergency Bypass Detection Kit shall support an optional tap kit for normally power loss sensing within an ETC Unison DRd Enclosure
         b) The Tap Kit shall provide fused over-current protection for sense feed wiring without the need for an external circuit breaker
         c) The Tap Kit shall install within an ETC Unison DRd Enclosure
      2) Emergency Bypass Restore Switch (EBDK-SWITCH)
         a) The Emergency Bypass Detection Kit shall support an optional switch kit ,requiring manual override before allowing the EBDK to return to a normal power state
         b) The Restore Switch shall be a single-gang device, fully finished, and supplied with mounting holes.
            (1) The EBDK Switch Kit shall be clearly labeled identifying intended operation
            (2) The Switch shall be labeled Lighting System Restore
            (3) The Switch shall include a red indicator that is illuminated when bypass operation is active

c) The EBDK Switch shall require two 16-gauge wires for connection to the Emergency Bypass Detection Kit
(1) Up to two Bypass Restore Switches shall be supported per Emergency bypass Detection it

3. Electrical
   a. Emergency Bypass Detection enclosures shall support 100 to 277 volt configurations
      1) EBDK enclosures shall be field configurable for single-phase, bi-phase, and three-phase operation without the need for additional components.
   b. Phase Loss Detection circuitry shall provide 0.5 second delay to prevent nuisance tripping
   c. The EBDK shall provide an integrated circuit breaker for over-current protection and simulation of normal power loss
   d. The Emergency bypass detection Kit shall support isolated outputs for connection to multiple dimming products simultaneously
      1) Three isolated contacts shall be provided
      2) Each contact shall support connection of up to four dimming products.
   e. The Emergency Bypass Detection Kit shall be completely pre-wired by the manufacturer. The contractor shall provide input feed and control wiring.
   f. All control wire connections shall be terminated via factory provided connectors.
      1) Factory provided connector shall support 12 to 22-gauge wiring
      2) Emergency lighting input shall support load shedding
   g. The Bypass Detection Kit shall prove a normally-closed input for interface with fire alarm systems
   h. The Bypass Detection Kit shall be UL and cUL Section 924 Listed for interaction with similarly listed dimming and switching panels
4. Thermal
   a. Ambient room temperature: 0-40°C / 32-104°F
   b. Ambient humidity: 10-90% non-condensing

2.14 DMX EMERGENCY BYPASS CONTROL

A. Where Required To Trigger Special-Purpose Lighting Presets And Bypass Normal Lighting Controls During Emergency Or Panic Situations, The Bypass Means Shall Be The DMX Emergency Bypass Controller (DEBC) As Manufactured By Electronic Theatre Controls, Inc., Or Equal.

B. Functional
   1. The DMX Emergency Bypass Controller shall be capable of overriding a single universe of ANSI E1.11–2008, USITT DMX512-A control signals from "Normal" to "Bypass" when a trigger signal is detected via a two-pin trigger input.
      a. The DMX Emergency Bypass Controller shall poll the bypass trigger input after a power loss and react upon start up.
      b. The default or recorded sequence shall be recalled immediately on restart if the trigger is also applied at restart.
   2. The DMX Emergency Bypass Controller shall be capable of recording a single DMX preset (snapshot) of 512 channels for recall during "Bypass" mode.

C. Mechanical
   1. The DMX Emergency Bypass Controller (DEBC) enclosure shall be a surface mounted, constructed of 16-gauge, formed steel panels with a removable front cover.
      a. All components shall be properly treated and finished.
         1) Exterior surfaces shall be finished in fine textured, scratch-resistant, powder coat paint

b. DEBC enclosure shall have a minimum of four keyed mounting holes for wall attachment.
c. DEBC enclosure shall have a visible label stating the product name, manufacturer name, indicator functions, control functions, ratings and listings.

2. The DMX Emergency Bypass Controller (DEBC) enclosure shall provide discrete high and low voltage wiring compartments with voltage barrier.
   a. DEBC shall support labeled, non-socketed terminations for two 24 – 10 AWG solid or stranded power wires
   b. DEBC shall support one Grounding Lug for 24-14 AWG solid or stranded ground wire.
   c. DEBC shall support labeled, socketed termination connections for DMX Input and DMX Output wiring.
      1) Terminations shall support Belden 9729 cable or equivalent.
         a) DMX Termination kits for Belden 9729 shall be supplied with the controller.
         b) Optional Termination kits for Belden 1583A (or equivalent Category 5 cable) shall be available from the manufacturer.
   d. DEBC shall support labeled, socketed termination for the bypass contact input.
      1) Termination shall support two, 30-12 AWG low-voltage wires
3. The DMX Emergency Bypass Controller (DEBC) shall have a single bi-color LED indicator visible from the exterior of the enclosure.
   a. LED shall indicate Normal state with a "green" color light
      1) Normal state illuminates steady green when Power and DMX are present
      2) LED Off indicates Power or DMX are not present
   b. LED shall indicate Bypass state with a "red" color light
      1) Bypass state includes bypass input contact trigger or test' active
4. The DMX Emergency Bypass Controller (DEBC) shall have a single test button accessible from the front of the enclosure without removing any panels.
   a. The test button shall immediately trigger bypass state for as long as it is held down, and release the bypass state immediately.
      1) The test button shall be momentary only
      2) The test button shall be recessed to prevent accidental triggering
5. The DMX Emergency Bypass Controller (DEBC) shall have internally accessible, labeled DIP switches for configuration of:
   a. DMX Record Mode
      1) All 512 channels (default)
      2) Selected channels, snapshot
   b. Contact input type
      1) Normally Open (default)
      2) Normally Closed
   c. Wait Time for Restore incoming DMX (bypass trigger removed)
      1) 0 Seconds (default)
      2) 10 Second Wait
      3) 30 Second Wait
      4) 10 Minute Wait
6. The DMX Emergency Bypass Controller (DEBC) shall have a single, internally accessible button for DMX Record (snapshot) with an indicator LED for record action.
      1) The record button shall be momentary only and held for at least 3 seconds before activation to prevent accidental recording.
      2) The LED indicator will flash rapidly when record function is active.
      3) The LED indicator will illuminate steady when record function is complete.
7. The DMX Emergency Bypass Controller (DEBC) dimensions and weights shall not exceed:
   a. 9" H x 11" W x 2" D,
   b. 8 lb.

D. Electrical
1. The DMX Emergency Bypass Controller shall be completely internally pre-wired by the manufacturer.
2. The contractor shall provide input feed and control wiring.
   a. DMX Emergency Bypass Controllers (DEBC) shall support 100 to 277 volt input power, 50/60 Hz, 150mA maximum current.
3. The DMX Emergency Bypass Controller shall support a single bypass input using two input modes:
   a. The bypass input will send +12VDC through a remote dry contact and return it back to the device, or
   b. The remote device may also supply +12VDC on its own to trigger a wet contact input.
   c. The DMX Emergency Bypass Controller bypass input shall be configurable for two functions using maintained dipswitches:
      1) Maintained Normally Open (N.O.), or
      2) Maintained Normally Closed (N.C.).
4. The DMX Emergency Bypass Controller (DEBC) shall support one Universe (512 channels) of Digital Multiplexing (DMX) in accordance with ANSI E1.11–2008, USITT DMX512-A.
   a. Controllers that do not support E1.11–2008 compliant DMX communication shall not be acceptable
   b. DEBC shall support socketed DMX transceiver chips.
      1) A spare DMX transceiver chip shall be supplied in a labeled, inactive socket.
5. The DMX Emergency Bypass Controller (DEBC) shall not process (pass-through) the normal DMX input
6. The DMX Emergency Bypass Controller (DEBC) shall internally switch from the normal DMX input (pass through) to the bypass DMX output using electromechanical relays when triggered.
   a. The DEBC shall have non-volatile memory for storage of a single recorded sequence of 512 channels.
      1) The recorded sequence shall persist through power outages
      2) The default sequence shall have all 512 channels at "full" if no sequence is recorded.
   b. The DEBC shall have a DMX baud rate of "Slow" (20 packets per second) for compatibility during bypass DMX output
7. The DMX Emergency Bypass Controller shall be UL and cUL Section 924 Listed for interaction with similarly listed products.

E. Thermal
1. Ambient room temperature: 0-40°C / 32-104°F
2. Ambient humidity: 10-90% non-condensing

2.15 COLOR MIXING OR WHITE-LIGHT LIGHT EMITTING DIODE PROFILE FIXTURE

A. General
1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a Source Four LED as manufactured by Electronics Theatre Controls, Inc. or approved equal.
2. All LED fixtures shall be provided by a single manufacturer to ensure compatibility
3. The fixture shall be UL 1573 listed for stage and studio use
4. The fixture shall comply with the USITT DMX-512A standard

B. Physical
1. The unit shall be constructed of rugged, die cast aluminum, free of burrs and pits, finished in black.
2. The following shall be provided:
   a. Lens secured with silicone shock mounts
   b. Shutter assembly shall allow for +/-25° rotation
   c. 20 gauge stainless steel shutters
   d. Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement
   e. Sturdy integral die cast gel frame holders with two accessory slots, and a top-mounted, quick release gel frame retainer
   f. Rugged steel yoke with two mounting positions allowing 300°+ rotation of the fixture within the yoke
   g. Positive locking, hand operated yoke clutch

h. Slot with sliding cover for motorized pattern devices or optional iris
3. The housing shall have a rugged black powder coat finish
   a. White or silver/gray powder coat finishes shall be available as color options
   b. Other powder coat color options shall be available on request
4. Power supply, cooling and electronics shall be integral to each unit.
5. The unit shall ship with
   a. Theatrical-style hanging yoke as standard
   b. 5' Neutrik PowerCon™ to Edison power cable as standard
   c. Gate diffuser
   d. A-size pattern holder
6. Available options shall include but not be limited to:
   a. Bare-end, Stage-Pin or Twist-lock type-equipped power leads
   b. PowerCon to PowerCon cables for fixture power linking
   c. Smooth Wash Diffuser for overlapping beams of light from multiple fixtures

C. Optical
1. The light beam should have a 2-to-1 center-to-edge drop-off ratio
2. The unit shall provide, but not be limited to:
   a. Low gate and beam temperature
   b. Sharp imaging through a three-plane shutter design
3. The unit shall provide, but not be limited to:
   a. 5, 10, 14, 19, 26, 36, 50, 70 and 90 degree field angles
   b. High-quality pattern imaging
   c. Sharp shutter cuts without halation
   d. Shutter warping and burnout in normal use shall be unacceptable
   e. Adjustable hard and soft beam edges
4. 19, 26, 36, and 50 degree units shall have optional lens tubes available for precision, high-contrast imaging.

D. Environmental And Agency Compliance
1. The fixture shall be ETL and cETL LISTED and/or CE rated, and shall be so labeled when delivered to the job site.
2. The fixture shall be ETL LISTED to the UL1573 standard for stage and studio use
3. The fixture shall be rated for IP-20 dry location use.

E. Thermal
1. Fixture shall be equipped with a cooling fan.
   a. Fan speed control via a DMX channel shall be possible
   b. Fan speed software shall permit the fixture to override DMX fan speed setting to prevent heat damage to the fixture
2. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use
   a. Thermal management shall include multiple temperature sensors within the housing to include:
      1) LED array circuit board temperatures
      2) Temperature sensors placed on each individual LED color circuit
      3) Fixture ambient
      4) CPU
   b. Fixture user shall permit monitoring of temperature sensors via a legible LCD multi-line backlit display
   c. Fixtures that do not provide active thermal monitoring of LED circuits and other temperature readings shall not be acceptable
3. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature.

F. Electrical
1. The fixture shall be equipped with a 100V to 240V 50/60Hz internal power supply
2. The fixture shall support power in and thru operation
   a. Power in shall be via Neutrik® PowerCon™ input connector
   b. Power thru shall be via Neutrik ® PowerCon ™ output connector

c. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker
3. The fixture requires power from a non-dim source
4. Power supply outputs shall have self-resetting current-limiting protection
5. Power supply shall have power factor correction

G. Led Emitters
1. The fixture shall contain a minimum of five different LED colors to provide color characteristics as described in the Color Section below
2. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
a. Fixture shall utilize Luxeon® Rebel™ LED emitters
3. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
4. LED emitters should be rated for nominal 20,000-hour LED life to 70% intensity
5. All LED fixtures (100% of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.
6. LED system shall comply with all relevant patents

H. Calibration
1. Fixture shall be calibrated at factory for achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins
a. Calibration data shall be stored on the LED array as a permanent part of on-board operating system
b. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency
c. Fixtures not offering LED calibration shall not be acceptable

I. Color
1. The fixture shall utilize a minimum of 60 LED emitters
2. The fixture shall be available in specialized LED arrays as outlined below:
a. Source Four LED Series 2 Lustr
1) Red, Amber, Green, Cyan, Blue, Indigo and Lime LEDs in an array designed for broad spectrum color, light tints, and variable whites. This array shall be the Lustr array as manufactured by Electronic Theatre Controls, or approved equal
a) Measured brightness of the Lustr array shall be greater than 6,500 field lumens

J. Dimming
1. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming.
2. At least four different dimming curve options shall be accessible at the fixture' s User Interface
a. Incandescent
b. Standard
c. Linear
d. Quick
3. Dimming curves shall be optimized for smooth dimming over longer timed fades.
4. The LED system shall be digitally driven using high-speed pulse width modulation (PWM)

5. LED control shall be compatible with broadcast equipment in the following ways:
    a. PWM control of LED levels shall be imperceptible to video cameras and related equipment
    b. PWM rates shall be adjustable by the user at the fixture if necessary to avoid any visible interference to video cameras and related equipment

K. Control And User Interface
1. The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors
2. The fixture shall be compatible with the ANSI RDM E1.20 standard
    a. All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
    b. Temperature sensors within the luminaire shall be viewable in real time via RDM
    c. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible
3. The fixture shall be equipped with multi-line LCD display for easy-to-read status reports and configuration changes
4. The fixture shall be equipped with a six-button user-interface
5. The fixture shall offer multiple DMX input profile options to include:
    a. RGB - control of all individual LED colors via a three-channel profile
        1) Red, Green, Blue
    b. HSI – control of all individual LED colors via a three-channel profile
        1) Hue, Saturation, Intensity
    c. HSIC – control of all LED colors via a four-channel profile
        1) Hue, Saturation, Intensity and Color Point
            a) Color point provides variable color temperature settings
    d. Direct – control of each individual color channel via an independent channel
    e. Studio – Control of the fixture in a white-light 3 channel profile
        1) Intensity, Color Temperature, +/- Green (Tint)
            a) Without DMX the fixture can master other Source Four LEDs and Desire fixtures that are connected via 5 pin XLR DMX cables
    f. A variable-rate strobe channel shall be provided
6. The fixture shall offer three output settings
    a. Boost mode - powers LEDs at maximum intensity and provides no compensation against LED droop' or intensity loss
    b. Regulated mode – slightly restricts maximum LED intensity levels to compensate against LED droop
    c. Protected mode – further restricts maximum LED intensity levels to compensate against LED droop and offer color consistency at highest permissible ambient temperatures (40C)
    d. Fixtures that do not provide regulated and protected operation modes are not acceptable
7. The fixture shall offer additional user-definable options to including but not limited to
    a. Display time out options
    b. Loss of data behavior options
    c. White point settings
    d. Red-shift option for tungsten dimming emulation
8. The fixture shall offer five Quick Set-Ups to allow user to rapidly select different combinations of the numerous user options based on the desired usage situation, to include:
    a. General – for most situations
    b. Stage – when emulating incandescent fixtures is desired
    c. High Impact – when maximum output and effect is desired
    d. XT Arch – when color consistency and architectural characteristics are desired.
    e. Studio - when DMX or stand-alone of white light output is required with intensity, color temperature and color tint control parameters

9. The fixture shall offer stand-alone functionality eliminating the need for a console
    a. Fixture shall ship with 24 preset colors accessible as a stand-alone feature
    b. Fixture shall ship with 12 sequences accessible as a stand-alone feature
    c. Each color and sequence can be modified by the end user
    d. Fixtures can be linked together with standard DMX cables and controlled from designated master fixture
        1) Up to 32 fixtures may be linked
    e. Fixtures in a stand-alone state shall restore to the settings present prior to power cycling, eliminating the need for reprogramming
    f. Fixtures without stand-alone operation features described above shall not be acceptable
10. The fixture shall be capable of copying all performance settings to other fixtures of the same type via a 5 pin XLR DMX cable

2.16 COLOR MIXING LIGHT EMITTING DIODE WASH FIXTURE

A. General
1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a Desire D40 or D40 Studio as manufactured by Electronics Theatre Controls, Inc. or approved equal.
2. All LED fixtures shall be provided by a single manufacturer to ensure compatibility
3. The fixture shall be UL 1573 listed for stage and studio use
4. The fixture shall comply with the USITT DMX-512 A standard.

B. Physical
1. The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits
2. The housing shall have a rugged black powdercoat finish
    a. White or silver/gray powdercoat finishes shall be available as color options
    b. Other powdercoat color options shall be available on request
3. Power supply, cooling and electronics shall be integral to each unit.
4. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories
    a. Slots shall be equipped with locking retaining clip
5. The unit shall ship with
    a. Theatrical-style hanging yoke as standard
    b. 5' power lead with Edison connector as standard
    c. 25 deg. secondary lens as standard
6. Available options shall include but not be limited to:
    a. Yoke with floor stand conversion feature
    b. Bare-end, Stage-Pin or Twist-lock type-equipped power leads
    c. PowerCon to PowerCon cables for fixture power linking
    d. Multiple secondary lens options to include multiple angles in the following patterns:
        1) Linear
        2) Round
        3) Oblong
7. Light output shall be via a round aperture
    a. Aperture and accessory slots shall accommodate standard 7.5" accessories such as used in other similar-sized fixtures
    b. Accessories available as options shall include but not be limited to:
        1) Gel/diffusion frames
        2) Top hats
        3) Barndoors
        4) Egg crate louvers
        5) Concentric ring louvers
        6) Multiple secondary lensing options

C. Environmental And Agency Compliance
   1. The fixture shall be UL and cUL LISTED and/or CE rated, and shall be so labeled when delivered to the job site.
   2. The fixture shall be UL LISTED to the UL1573 standard for stage and studio use
   3. The fixture shall be rated for IP-20 dry location use.

D. Thermal
   1. Fixture shall be totally convection cooled, requiring no cooling fan. Fixtures which require an on-board cooling fan shall not be acceptable unless pre-approved
   2. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 50,000 hours of use
      a. Thermal management shall include multiple temperature sensors within the housing to include:
         1) LED array circuit board temperatures
         2) Temperature sensors placed on each individual LED color circuit
         3) Fixture ambient
         4) CPU
      b. Fixture user shall permit monitoring of temperature sensors via a legible LCD multi-line backlit display
      c. Fixtures that do not provide active thermal monitoring of LED circuits and other temperature readings shall not be acceptable
   3. The fixture shall operate in an ambient temperature range of -20°C (-4°F) minimum, to 40° C (104°F) maximum ambient temperature.

E. Electrical
   1. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply
   2. The fixture shall support power in and thru operation
      a. Power in shall be via Neutrik® PowerConinput connector
      b. Power thru shall be via Neutrik ® PowerCon output connector
      c. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker
   3. The fixture requires power from non-dim source
   4. Power supply outputs shall have self-resetting current limiting protection
   5. Power supply shall have power factor correction

F. Led Emitters
   1. The fixture shall contain a minimum of 5 different LED colors to provide color characteristics as described in Section G below
   2. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
      a. Fixture shall utilize Luxeon® RebelLED emitters
   3. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
   4. LED emitters should be rated for nominal 50,000 hour LED life to 70% intensity
   5. All LED fixtures (100% of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.
   6. LED system shall comply with all relevant patents

G. Calibration
   1. Fixture shall be calibrated at factory for achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins
      a. Calibration data shall be stored on the LED array as a permanent part of on-board operating system
      b. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency
      c. Fixtures not offering LED calibration shall not be acceptable

H. Color
   1. The fixture shall utilize an minimum of 40 LED emitters
   2. The fixture shall be available in specialized LED arrays as outlined below:
      a. Desire D40
         1) Red, Amber, Green, Cyan, Blue, Indigo and White LEDs in an array designed for broad spectrum color, light tints, and variable whites. This array shall be the Lustr+ array as manufactured by Electronic Theatre Controls, or approved equal
            a) Measured brightness of the Lustr+ array shall be greater than 2900 field lumens
         2) Red, Orange, Amber, Green, Cyan, Blue and Indigo LEDs in an array designed for broad spectrum deep colors. This array shall be the Vivid array as manufactured by Electronic Theatre Controls, or approved equal
            a) Measured brightness of the Vivid array shall be greater than 2500 field lumens
         3) Red, Orange, Amber, Green and Indigo LEDs in an array designed for extra-high brightness output in red/warm end of the spectrum. This shall be the Fire array as manufactured by Electronic Theatre Controls, or approved equal
            a) Measured brightness of the Fire array shall be greater than 2500 field lumens
         4) Red, Orange, Green, Cyan, Blue and Indigo LEDs in an array designed for extra-high brightness output in the blue/cool end of the spectrum. This shall be the Ice array as manufactured by Electronic Theatre Controls, or approved equal
            a) Measured brightness of the Ice array shall be greater than 1800 field lumens
      b. Desire D40 Studio
         1) Warm White, Cool White, Red, Green, Blue and Indigo LEDs in an array designed for high-brightness variable color temperature white light output. This shall be the Studio HD array as manufactured by Electronic Theatre Controls, or approved equal
            a) Measure brightness of the Studio HD array shall be greater than 3100 field lumens
         2) All Warm White LEDs in an array designed for non-variable single color high-output, warm white light. This shall be the Studio Tungsten array as manufactured by Electronic Theatre Controls, or approved equal
            a) Measure brightness of the Studio tungsten array shall be greater than (TBD) field lumens
         3) All Cool White LEDs in an array designed for non-variable single color high-output, cool white light. This shall be the Studio Daylight array as manufactured by Electronic Theatre Controls, or approved equal
            a) Measure brightness of the Studio Daylight array shall be greater than (TBD) field lumens

I. Dimming
   1. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming.
   2. At least four different dimming curve options shall be accessible at the fixture' s User Interface
      a. Incandescent
      b. Standard
      c. Linear
      d. Quick
   3. Dimming curves shall be optimized for smooth dimming over longer timed fades.
   4. The LED system shall be digitally driven using high-speed pulse width modulation (PWM)
   5. LED control shall be compatible with broadcast equipment in the following ways:
      a. PWM control of LED levels shall be imperceptible to video cameras and related equipment
      b. PWM rates shall be adjustable by the user at the fixture if necessary to avoid any visible interference to video cameras and related equipment

J. Control And User Interface
   1. The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors
   2. The fixture shall be compatible with the ANSI RDM E1.20 standard
      a. All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
      b. Temperature sensors within the luminaire shall be viewable in real time via RDM
      c. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible
   3. The fixture shall be equipped with multi-line LCD display for easy-to-read status reports and configuration changes
   4. The fixture shall be equipped with a six-button user-interface
   5. The fixture shall offer multiple DMX input profile options to include:
      a. RGB - control of all individual LED colors via a three-channel profile
         1) Red, Green, Blue
      b. HSI – control of all individual LED colors via a three-channel profile
         1) Hue, Saturation, Intensity
      c. HSIC – control of all LED colors via a four-channel profile
         1) Hue, Saturation, Intensity and Color Point
            a) Color point provides variable color temperature settings
      d. Direct – control of each individual color channel via an independent channel
      e. A variable-rate strobe channel shall be provided
   6. The fixture shall offer three output settings
      a. Boost mode - powers LEDs at maximum intensity and provides no compensation against LED droop' or intensity loss
      b. Regulated mode – slightly restricts maximum LED intensity levels to compensate against LED droop
      c. Protected mode – further restricts maximum LED intensity levels to compensate against LED droop and offer color consistency at highest permissible ambient temperatures (40C)
      d. Fixtures that do not provide regulated and protected operation modes are not acceptable
   7. The fixture shall offer additional user-definable options to including but not limited to
      a. Display time out options
      b. Loss of data behavior options
      c. White point settings
      d. Red-shift option for tungsten dimming emulation
   8. The fixture shall offer five Quick Set-Ups to allow user to rapidly select different combinations of the numerous user options based on the desired usage situation, to include:
      a. General – for most situations
      b. Stage – when emulating incandescent fixtures is desired
      c. High Impact – when maximum output and effect is desired
      d. XT Arch – when color consistency and architectural characteristics are desired.
      e. Studio - when DMX or stand-alone of white light output is required with intensity, color temperature and color tint control parameters
   9. The fixture shall offer stand-alone functionality eliminating the need for a console
      a. Fixture shall ship with 24 preset colors accessible as a stand-alone feature

b. Fixture shall ship with 12 Sequences accessible as a stand-alone feature
c. Each color and sequence can be modified by the end user
d. Fixtures can be linked together with standard DMX cables and controlled from designated master fixture
    2) Up to 32 fixtures may be linked
e. Fixtures in a stand-alone state shall restore to the settings present prior to power cycling, eliminating the need for reprogramming
f. Fixtures without stand-alone operation features described in a, b, c, d, and e shall not be acceptable

2.17 COLOR MIXING LIGHT EMITTING DIODE WASH FIXTURE

A. General
1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a ColorSource Par as manufactured by Electronic Theatre Controls, Inc. or approved equal.
2. All LED fixtures shall be provided by a single manufacturer to ensure compatibility
3. The fixture shall be UL 1573 listed for stage and studio use
4. The fixture shall comply with the USITT DMX-512 A standard

B. Physical
1. The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits.
2. The housing shall have a rugged black powdercoat finish
    a. White or silver/gray powdercoat finishes shall be available as color options
    b. Other powdercoat color options shall be available on request
3. Power supply, cooling and electronics shall be integral to each unit.
4. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories
    a. Slots shall be equipped with locking retaining clip
5. The unit shall ship with:
    a. Theatrical-style hanging yoke as standard
    b. 5’ power lead with Edison connector as standard
6. Available options shall include but not be limited to:
    a. Floor stand conversion Kit
    b. Bare-end, Stage-Pin or Twist-lock type-equipped power leads
    c. PowerCon to PowerCon cables for fixture power linking
    d. Multiple secondary lens options to include multiple angles in the following patterns:
        1) Linear
        2) Round
        3) Oblong
7. Light output shall be via a round aperture
    a. Aperture and accessory slots shall accommodate standard 7.5” accessories such as used in other similar-sized fixtures
    b. Accessories available as options shall include but not be limited to:
        1) Gel/diffusion frames
        2) Top hats
        3) Barndoors
        4) Egg crate louvers
        5) Concentric ring louvers
        6) Multiple secondary lensing options

C. Environmental And Agency Compliance
   1. The fixture shall be UL and cUL LISTED and/or CE rated, and shall be so labeled when delivered to the job site.
   2. The fixture shall be UL LISTED to the UL1573 standard for stage and studio use
   3. The fixture shall be rated for IP-20 dry location use.

D. Thermal
   1. The fixture shall be cooled with a variable speed fan.
   2. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use
      a. Thermal management shall include multiple temperature sensors within the housing to including:
         1) The LED array
         2) The control board
   3. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature.

E. Electrical
   1. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply
   2. The fixture shall support power in and thru operation
      a. Power in shall be via Neutrik® PowerCon™ input connector
      b. Power thru shall be via Neutrik ® PowerCon ™ output connector
      c. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker
   3. The fixture requires power from non-dim source
   4. Power supply outputs shall have self-resetting current limiting protection
   5. Power supply shall have power factor correction

F. Led Emitters
   1. The fixture shall contain 4 different LED colors to provide color characteristics as described in Section H below.
   2. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
   3. Fixture shall utilize Luxeon® Z™ LED emitters
   4. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
   5. LED emitters should be rated for nominal 20,000 hour LED life to 70% intensity
   6. All LED fixtures (100% of each lot) shall undergo a minimum three-hour burn-in test during manufacturing.
   7. LED system shall comply with all relevant patents

G. Calibration
   1. Fixture shall be calibrated at factory for achieve consistent color between fixtures built at different times and/or from different LED lots or bins
      a. Calibration data shall be stored in the fixture as a permanent part of on-board operating system
      b. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency
      c. Fixtures not offering LED calibration shall not be acceptable

H. Color
   1. The fixture shall utilize an minimum of 40 LED emitters
      a. These emitters shall be made up of Red, Green, Blue and Lime

I. Dimming
   1. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming.
   2. The dimming curve shall be optimized for smooth dimming over longer timed fades.
   3. The LED system shall be digitally driven using high-speed pulse width modulation (PWM)
   4. LED control shall be compatible with broadcast equipment in the following ways:
      a. PWM control of LED levels shall be imperceptible to video cameras and related equipment

b. PWM rates shall be adjustable by the user via RDM to avoid any visible interference to video cameras and related equipment

J. Control And User Interface
1. The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors
2. The fixture shall be compatible with the ANSI RDM E1.20 standard
   a. All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
   b. Temperature sensors within the luminaire shall be viewable in real time via RDM
   c. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible
3. The fixture shall be equipped with a 7-segment display for easy-to-read status and control
4. The fixture shall be equipped with a three-button user-interface
5. The fixture shall offer RGB control
6. The fixture shall operate in Regulated mode for droop compensation
7. The fixture shall offer stand-alone functionality eliminating the need for a console
   a. Fixture shall ship with 12 preset colors accessible as a stand-alone feature
   b. Fixture shall ship with 5 Sequences accessible as a stand-alone feature
   c. Each color and sequence can be modified by the end user
   d. Fixtures can be linked together with standard DMX cables and controlled from designated master fixture
   e. Up to 32 fixtures may be linked
   f. Fixtures in a stand-alone state shall restore to the settings present prior to power cycling, eliminating the need for reprogramming
   g. Fixtures without stand-alone operation features described in a, b, c, d, and e shall not be acceptable.

2.18 POWER DISTRIBUTION – JUNCTION BOXES

A. General
1. Gridiron junction boxes shall be fabricated from 16-gauge cold rolled steel with 14 gauge end panels.
2. Junction boxes shall be finished with fine-textured, scratch-resistant, black powder coat.
   a. Boxes for 30 circuits or less shall be 14"H x 14"W x 4"D
   b. Boxes for 31 to 60 circuits shall be 14"H x 28"W x 4"D.
3. Junction boxes shall include mounting brackets and hardware
4. Cover(s) shall be 16-gauge cold rolled steel and hinge to allow installer to orient the hinged door to open in any horizontal direction.
5. Cover(s) shall be attached with machine screws and Tinnerman retainer nuts.

B. Electrical
1. Wiring terminations shall be made using feed through terminals individually labeled with corresponding circuit numbers.
   a. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire.
   b. 50 amp circuits shall use compression terminals listed for 10 – 1 gauge wire.
   c. 100 amp circuits shall use compression terminals listed for 8 – 2/0 gauge wire.
   d. Terminals that place a screw directly on the wire are not acceptable.
2. Gridiron junction boxes shall be listed by a nationally recognized test lab (nrtl).
3. A low voltage distribution system shall be available to incorporate DMX, Ethernet or other protocols as specified with the gridiron junction box.
   a. Low voltage junction boxes shall attach to gridiron junction boxes to simplify wiring to a discrete device
   b. Low voltage signals shall enter the junction box via a strain relief or connector mounted in a separate low voltage terminal box on the top or bottom of the gridiron junction box.
   c. Up to four low voltage cables shall be supported for each junction box location.

2.19 POWER DISTRIBUTION – CONNECTOR STRIPS

A. General
1. Connectors shall be available as 20A, 50A and 100A grounded stage pin, 20A twist lock and 20A "U" ground (dual rated "T-slot"); other connectors shall be available as specified.

2. Internal wiring shall be sized to circuit ampacity and shall be rated at 125°C.
3. Pigtails shall be three-wire type "SOW" rubber jacketed cable sized for the maximum circuit ampacity.
4. Pigtails with 20 amp stage pin connectors shall be terminated using 12 gauge 4 way indent crimp (with inspection window) type where the wire is inserted and crimped directly in the socket.
5. Terminations shall be at one end using feed-through terminals individually labeled with corresponding circuit numbers.
    a. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire.
    b. 50 amp circuits shall use compression terminals listed for 10 – 1 gauge wire.
    c. 100 amp circuits shall use compression terminals listed for 8 – 2/0 gauge wire.
    d. Terminals that place a screw directly on the wire are not acceptable.
6. Connector strips shall be supplied with appropriate brackets and hardware for mounting as shown on the drawings
    a. Connector strips shall have junction brackets on 5' centers.
    b. Brackets shall be 1 x .188" ASTM A 36 steel
    c. Hardware shall be ASTM A307 grade 5.
7. A low voltage distribution system shall be available to incorporate DMX, Ethernet or other protocols as specified in the connector strip. Connector strips shall utilize a voltage barrier to accommodate these systems. Low Voltage signals shall enter the connector strip via a strain relief or connector mounted in a separate low voltage terminal box at the specified end of the connector strip. Up to four low voltage cables shall be supported for each connector strip.
    a. Connector strips with multiple DMX outputs from the same source shall use DMX pass through assemblies consisting of a 6" panel with the one DMX output connector, one DMX input (Pass Through) connector, one DMX pass through (Bypass) switch, and a label detailing the use of the pass through assembly.
    b. The bypass switch shall be used when no DMX devices are present at that location. When activated, the DMX pass through switch shall pass DMX directly through to the next DMX panel on the strip. The pass through switch shall have a mechanical indicator to show the operator that it has or has not been engaged
8. Connector Strips shall be listed by a nationally recognized test lab (nrtl).

B. Physical
1. Connector strips shall be 6.25" H x 3.3" D and fabricated from 18-gauge galvanized steel and finished in black fine-texture powder coat paint.
    a. Covers shall be fabricated from 16-gauge galvanized steel
2. Connector strips shall be available in any length specified in increments of 6" and shipped fully wired with all splicing hardware.
3. Pigtails and outlets shall be spaced on 18" centers, or as otherwise specified.
4. Outlets shall be mounted on individual 3" panels and there shall be
5. No external terminal boxes shall be required for connector strips with 28 or fewer circuits unless otherwise specified.
6. Circuits shall be labeled on the connector strip with 2" lettering.
    a. Circuit labeling options shall include
        1) Circuits shall be labeled on the front side of the connector strip with white lettering on black background labels.
        2) Circuits shall be labeled on front and back sides of the connector strip with white lettering on black background labels.
        3) Circuits shall be labeled on the front side of the connector strip with engraved lamicoid labels utilizing white lettering on black background labels.
        4) Circuits shall be labeled on the front and rear sides of the connector strip with engraved lamicoid labels utilizing white lettering on black background labels.
        5) Circuits shall be labeled on one side of the connector strip using individual circuit cover plates with lettering engraved in the cover and filled with the specified color.
        6) Circuits shall be labeled using specified labeling per plans and drawings
7. Connector strips shall support optional LED indicators to indicate the presence of power at each local circuit. The indicator shall be red in color and mounted in the connector strip
    a. The LED indicator shall be mounted in the lower right corner of the outlet panel
    b. The LED indicator shall be mounted in the connector strip trough directly below the outlet panel.

c. The LED indicator shall be mounted in the center of the 3" plate directly below the circuit label for pigtail circuits

C. Junction Boxes
1. Gridiron junction boxes shall be available to accommodate SO or SOW cable wiring into connector strips mounted to non-fixed locations
2. Junction Boxes shall be fabricated from 16-gauge cold rolled steel with 14 gauge end panels. They shall be finished with fine-textured, scratch-resistant, black powder coat paint. Cover(s) shall be 16-gauge cold rolled steel and hinged to allow mounting in any direction.

2.20 POWER DISTRIBUTION – OUTLET AND PIGTAIL BOXES

A. General
1. Connectors shall be available as 20A, 50A and 100A grounded stage pin, 20A twist lock and 20A "U" ground (dual rated "T-slot"); other connectors shall be available as specified.
2. Pigtails shall be three-wire type "SOW" rubber jacketed cable sized for the maximum circuit ampacity.
3. Pigtails with 20 amp stage pin connectors shall be terminated using 12 gauge 4 way indent crimp (with inspection window) type where the wire is inserted and crimped directly in the socket.
4. Terminations for pigtail connectors shall utilize feed- through terminals individually labeled with corresponding circuit numbers.
   a. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire.
   b. 50 amp circuits shall use compression terminals listed for 10 – 1 gauge wire.
   c. 100 amp circuits shall use compression terminals listed for 8 – 2/0 gauge wire.
   d. Terminals that place a screw directly on the wire are not acceptable.
5. Outlet and pigtail boxes shall be supplied with appropriate brackets and hardware for mounting as shown on the drawings
   a. Standard mounting options shall include pipe or wall mounting
   b. Brackets shall be made from ASTM A 36 steel
   c. Hardware shall be ASTM A307 grade 5.
6. A low voltage distribution system shall be available to incorporate DMX, Ethernet or other protocols as specified in the power distribution box.
   a. A voltage barrier shall be used to separate the low voltage wiring for the electrical circuits.
7. Power distribution equipment shall be listed by a nationally recognized test lab (nrtl).

B. Physical
1. Outlet and pigtail boxes shall be 6.25" H x 3.3" D and fabricated from 18 gauge galvanized steel and finished in black fine-texture powder coat paint.
   a. Covers shall be fabricated from 16-gauge galvanized steel
2. Outlet and pigtail boxes shall be available in any length specified in increments of 3-inches with a maximum length of up to 3-feet.
3. Pigtails and outlets shall be spaced on 18" centers, or as otherwise specified.
4. Outlets shall be mounted on individual 3" panels.
5. Circuits shall be labeled with 1.25" lettering.
   a. Circuit labeling options shall include:
6. Circuits shall be labeled on the front side of the connector strip with white lettering on black background labels.
7. Circuits shall be labeled on front and back sides of the connector strip with white lettering on black background labels.
8. Circuits shall be labeled on the front side of the connector strip with engraved lamicoid labels utilizing white lettering on black background labels.
9. Circuits shall be labeled on the front and rear sides of the connector strip with engraved lamicoid labels utilizing white lettering on black background labels.
10. Circuits shall be labeled on one side of the connector strip using individual circuit cover plates with lettering engraved in the cover and filled with the specified color.
11. Circuits shall be labeled using specified labeling per plans and drawings
12. Outlet and pigtail boxes shall support optional LED indicators to indicate the presence of power at each local circuit. The indicator shall be red in color and mounted in outlet or pigtail box.
   a. The LED indicator shall be mounted in the lower right corner of the outlet panel

b. The LED indicator shall be mounted in the bottom of the outlet or pigtail box directly below the outlet panel.
c. The LED indicator shall be mounted in the cover plate directly below the circuit label for pigtail circuits

2.21 NETWORK SERVICES GATEWAY

A. General
1. The lighting network service gateway shall be a microprocessor-based unit specifically designed to provide network services and storage for lighting control systems. The gateway shall provide all necessary network services for automatic network configuration over an Ethernet network. The unit shall be a Net3 Conductor as provided by ETC, Inc.
2. The gateway shall communicate over Ethernet directly with ETC, Inc.' s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.
4. The gateway shall support multiple protocols including:
   a. Dynamic Host Control Protocol (DHCP) for automatic assignment of IP address
   b. Dynamic Name Service (DNS)
   c. Simple Network Time Protocol (sNTP) for automatic time assignment and synchronization
   d. File Transfer Protocol (FTP) for configuration storage and backup
   e. Windows File Sharing (SMB) for configuration and file storage and backup
5. The gateway shall support real-time logging and notification of system errors.
   a. Logging shall utilize a standard Syslog database. Databases that do not utilize Syslog shall not be acceptable.
   b. Notifications shall utilize an email system.
6. The gateway shall support storage of system device configurations and complete stem configurations. Configuration storage for the following device types is required:
   a. Power panels including relays and dimmers
7. User definable reports that detail historical errors and power usage shall be supported. Reports shall be generated using the gateway database and queried from Net3 Concert software or another 3rd party application.

B. Mechanical
1. The gateway shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, black powder coat.
2. The gateway shall have front panel, backlit power button.
3. The gateway shall provide rear panel connections for low voltage power supply input.
4. The gateway shall provide two rear panel Ethernet connections:
   a. One shall be dedicated to the local lighting control network.
   b. The second shall support connection to a building network or secured internet connection for remote monitoring and reporting.
5. Dimensions shall be 8.5" (22 cm) wide x 9.55" (243cm) deep x 1.75" (5 cm) high.
6. Mounting holes shall be provided for installation of a 19" one E.I.A unit rack mount accessory kit.

C. Electrical
1. Power for the gateway shall be provided via an isolated in-line power supply rated for 5A at 12vDC provided by the gateway manufacturer.
2. All Ethernet connections and communications shall be compliant with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and utilize standard Ethernet switches
3. The gateway shall be tested to UL standards and labeled ETL Listed.
4. The gateway shall be RoHS Compliant (lead-free).
5. The gateway shall be CE compliant.

D. Configuration
1. The gateway on the network shall be individually configurable using:
   a. Integrated Web Interface
   b. Net3 Concert configuration software.
2. The Gateway shall support automatic assignment of IP addresses to the entire Lighting Control System when DHCP is enabled

3. The Gateway shall support time assignment and synchronization of the lighting system using sNTP to ensure reliable playback from all devices
4. All information shall be stored in non-volatile memory at each gateway. The system shall recover from a power outage without requiring user interaction. Gateways that do not support non-volatile storage shall not be accepted

E. Network
1. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
2. ANSI E1.17 Architecture for Control Networks (ACN) shall be supported. Gateways that do not support ANSI E1.17 shall not be acceptable.

F. Environmental
1. The ambient operating temperature shall be 0° to 40°C (32° to 104°F).
2. The storage temperature shall be -40° to 70°C (-40° to 158°F).
3. The operating humidity shall be 5% - 95% non-condensing.

G. Accessories
1. One E.I.A. rack space mounting bracket kit shall support mounting of up to two complete gateways, including DMX gateways
2. A Universal Power Supply with international plug-set shall be available. Multiple power supplies shall be able to fit in a vertically stacked power strip.
3. Net3 Concert Configuration software

H. System Requirements
1. Gateways and software shall be as manufactured by Electronic Theatre Controls Inc. of MiddletonWI
2. Provide Ethernet switches and power supplies as scheduled and as shown on drawings.
3. Provide a current generation PC with Windows operating system equipped with a 10/100 Ethernet card.
4. Systems that do not provide the above capabilities shall not be acceptable

2.22 DMX ETHERNET GATEWAY – ONEPORT

A. General
1. The lighting control gateway shall be a microprocessor-based unit specifically designed to provide DMX-512 control of lighting. The gateway shall permit DMX-512 data to be encoded, routed over an Ethernet network and decoded back to DMX-512. The unit shall be a Net3 DMX 1-port Gateway as provided by ETC, Inc.
2. Gateways shall communicate over Ethernet directly with at least ETC, Inc.'s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.
4. The gateway shall support multiple protocols including:
   a. ANSI E1.31 Streaming ACN (sACN)
   b. ANSI E1.11 USITT DMX512-A
   c. ETCNet2 protocol suite
   d. ETCNet protocol suite
5. The gateway shall be tested to UL standards and labeled ETL Listed.
6. The gateway shall be RoHS Compliant (lead-free).
7. The gateway shall be CE compliant.
8. The gateway shall be configurable using Network Configuration Editor (NCE) software.
9. Each gateway shall have power and network activity LEDs

B. Dmx Ports
1. DMX Port shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
2. The DMX port shall be software-configurable for either input or output functionality.
3. Hardware configuration override setting shall be provided on the gateway.
4. DMX input shall be optically-isolated from the gateway electronics.
5. DMX output shall be earth-ground referenced.
6. DMX Port shall be capable of withstanding fault voltages of up to 250vAC without damage.
7. Each port shall incorporate one DMX512-A Connection

a. Each DMX port location shall support a single 5-pin male XLR or 5-pin female XLR

8. Network gateways that do not indicate input/ output port configuration or presence of valid data shall not be accepted

C. Processor
1. Maximum delay time from input to output shall not be greater than one packet time (approximately 22 mSec.).
2. A minimum DMX update rate of 40Hz shall be sustained under all conditions unless specifically configured for a slower rate for the sake of compatibility with 3rd party DMX devices.

D. Mechanical
1. The gateway faceplate shall be constructed of durable cast aluminum and mount in a standard 1 gang backbox. Faceplates manufactured of plastic shall not be acceptable.
2. Gateways shall be provided in matte black powder coat finish.
3. The gateway shall be available in two versions
a. Wall mount gateway
1) The wall mount gateway shall support flush or surface mount applications using a standard RACO 690 backbox or equivalent.
2) Dimensions shall not be more than 2.75" (70mm) wide x 4.5" (115mm) High
3) Wall mount gateways shall not weigh more than.35 lbs (.16kgs)
b. Touring gateway
4) The touring gateway shall include a complete enclosure with Ethercon and power connectors for wiring terminations
5) Dimensions shall not be more than 4.5" wide (115mm) x 3.5" (89mm) deep x 6.34" (161mm) high (not including mounting hardware)
6) Touring gateways shall not weigh more than 2.5 lbs (1.1 kg).

E. Power
1. Power for the gateway shall be provided either over the Category 5 (or better) cable, utilizing IEEE 802.3af compliant Power over Ethernet distribution equipment. Power consumption shall not be greater than 5 watts.
2. The gateway electronics shall be electrically isolated from the power supplied over the Catagory5 (or better) cable.
3. Power may be provided from any IEEE 802.3af compliant power-over Ethernet distribution equipment, or by using conventional switches together with isolated in-line power supplies as provided by gateway manufacturer.

F. Configuration
1. Each gateway on the network shall be individually configurable using Network Configuration Editor (NCE), running on a network connected PC. The PC shall only be required for configuration, and shall not be required for normal operation of the system.
2. Each DMX gateway shall control up to 512 DMX addresses. The specific DMX data input or output by the gateway shall be freely configurable by the user. Duplicate outputs of DMX lines (DMX splitter) and discrete outputs shall be fully supported.
3. Multiple sACN sources may be combined with a priority may be assigned to each source sending data to the gateway.

G. Network
1. Communications physical layer shall comply with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and 802.3af for Power over Ethernet specifications.
2. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
3. Data transport shall utilize the TCP/IP suite of protocols to transfer the DMX data.
4. ANSI E1.31 streaming ACN (sACN) shall be supported. Gateways that do not support ANSI E1.31 shall not be acceptable.
5. Switches shall comply with power-over-Ethernet IEEE802.3af, unless a separate in-line power supply is provided.
6. Each DMX gateway shall control up to 512 DMX addresses, per DMX port within the confines of up to 63,399 universes (32,767,488 addresses) when using Streaming ACN (sACN) and 64 DMX universes (32,767 addresses) when using EDMX.

a. Multiple sources shall be supported by prioritized Highest Takes Precedence (HTP with priority). Each source shall support assignment of priority to allow override of default HTP behavior.
b. Each DMX port shall support its own universe and start address.

7. Gateways shall support built in priority on a per-universe or channel-by-channel basis. Gateways that do not support prioritized merging of multiple network sources at independent channel priorities shall not be accepted.

H. Environmental
1. The ambient operating temperature shall be 0° to 40°C (32° to 104°F).
2. The storage temperature shall be -40° to 70°C (-40° to 158°F).
3. The operating humidity shall be 5% - 95% non-condensing.

I. Accessories
1. Hanging bracket kit shall allow gateway to be mounted using C-Clamp to U-bolt Hardware.
2. ETC Network Configuration Editor (NCE) software

J. System Requirements
1. Provide the quantity and type of gateways required, as scheduled. Gateways and software shall be as manufactured by Electronic Theatre Controls Inc. of Middleton, WI.
2. Provide Ethernet switches and power supplies as scheduled and as shown on drawings.
3. Provide a current generation PC with Windows XP operating system equipped with a 10/100 Ethernet card.
4. Systems that do not provide the above capabilities shall not be acceptable

2.23 DMX GATEWAY – FOURPORT

A. General
1. The lighting control gateway shall be a microprocessor-based unit specifically designed to provide DMX-512 control of lighting systems and transport of RDM configuration and status messages. The gateway shall permit DMX-512 data to be encoded, routed over an Ethernet network and decoded back to DMX-512. The unit shall be a Net3 DMX 4-port Gateway as provided by ETC, Inc.
2. Gateways shall communicate over Ethernet directly with at least ETC, Inc.'s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.
4. The gateway shall support multiple protocols including:
a. ANSI E1.17 Architecture for Control Networks (ACN)
b. ANSI E1.11 USITT DMX512-A
c. ANSI E1.20 Remote Device Management (RDM)
d. Net3 protocol suite including ANSI E1.31 Streaming ACN (sACN).
5. The gateway shall be tested to UL standards and labeled ETL Listed.
6. The gateway shall be RoHS Compliant (lead-free).
7. The gateway shall be CE compliant.
8. The gateway shall have a backlit graphic LCD display for identification (soft-labeling) and status reporting. Labeling shall be user configurable using ANSI E1.17 Architecture for Control Network (ACN), Gateway Configuration Editor (GCE) software. The LCD display shall show DMX port configuration indication as well as indicate the presence of valid signal. Gateways that do not indicate port configuration (input/output) and valid data shall not be acceptable.
9. Each gateway shall have power and network activity LEDs on both the front and rear of the gateway

B. Dmx Ports
1. DMX Ports shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
2. Each DMX port shall be software-configurable for either input or output functionality.
3. Hardware configuration override setting shall be provided on the gateway.
4. DMX input shall be optically-isolated from the gateway electronics.
5. DMX output shall be earth-ground referenced.
6. DMX Port shall be capable of withstanding fault voltages of up to 250vAC without damage.
7. Each port shall incorporate one DMX512-A Connection
a. Each DMX port shall be modular and hot swappable

b. Each DMX port location shall support a single 5-pin male XLR, 5-pin female XLR or terminal strip module for DMX wiring.

8. Network gateways that do not indicate input/ output port configuration or presence of valid data shall not be accepted

C. Processor
1. Each gateway shall have sufficient processing power to manage up to 63,999 universes (32,767,488 addresses).
2. Maximum delay time from input to output shall not be greater than one packet time (approximately 22 mSec.).
3. A minimum DMX update rate of 40Hz shall be sustained under all conditions unless specifically configured for a slower rate for the sake of compatibility with 3rd party DMX devices.

D. Mechanical
1. The gateway shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, black powder coat.
2. Dimensions shall be 8.5" (22 cm) wide x 8.0" (20 cm) deep x 1.75" (5 cm) high.
3. The weight of the gateway shall be 3.5 lbs (1.6 kg) with four modules. An individual module shall weight no more than .25 lbs (.1 kg).
4. Mounting holes shall be provided for installation of a pipe mount accessory kit.

E. Power
1. Power for the gateway shall be provided either over the Category 5 (or better) cable, utilizing IEEE 802.3af compliant Power over Ethernet distribution equipment, or via conventional switches together with isolated in-line power supplies capable of an operating range of 8-28vDC provided by the gateway manufacturer. Power consumption shall not be greater than 5 watts.
2. The gateway electronics shall be electrically isolated from the power supplied over the Catagory5 (or better) cable.
3. Power may be provided from any IEEE 802.3af compliant power-over Ethernet distribution equipment, or by using conventional switches together with isolated in-line power supplies as provided by gateway manufacturer.

F. Configuration
1. Each gateway on the network shall be individually configurable using:
a. Any devices utilizing ANSI E1.17 ACN communications
b. Gateway Configuration Editor (GCE), running on a network connected PC. The PC shall only be required for configuration, labeling and signal routing, and shall not be required for normal operation of the system.
2. Each DMX gateway shall control up to 512 DMX addresses, within the confines of 63,999 universes. The specific DMX data input or output by the gateway shall be freely configurable by the user. Duplicate outputs of DMX lines (DMX splitter) and discrete outputs shall be fully supported.
3. Any number of DMX universes may be configured with any length up to 512 addresses. Any range of DMX input addresses shall support selection and routing to the specified sACN output.
4. Multiple sources may be combined and a priority may be assigned to each source. Each DMX port may have its own universe and start address.
5. All relevant routing information shall be stored in non-volatile memory at each gateway. The system shall recover from a power outage without requiring the PC to be online. Gateways that do not support non-volatile storage of data routing shall not be accepted

G. Network
1. Communications physical layer shall comply with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and 802.3af for Power over Ethernet specifications
2. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
3. Data transport shall utilize the TCP/IP suite of protocols to transfer the DMX data.
4. ANSI E1.17 Architecture for Control Networks (ACN) and streaming ACN (sACN) shall be supported. Gateways that do not support ANSI E1.17 shall not be acceptable.
5. Switches shall comply with power-over-Ethernet IEEE802.3af, unless a separate in-line power supply is provided.

6. Multiple DMX signal routing patches and multiple facilities shall be supported and limited only by the file storage capacity of the computer with ETC Gateway Configuration Editor (GCE) Software installed.
7. Each DMX gateway shall control up to 512 DMX addresses, per DMX port within the confines of up to 64,399 universes (32,767,488 addresses) using Streaming ACN (sACN).
    a. Any range of DMX addresses may be selected for each universe.
    b. Multiple sources shall be supported by prioritized Highest Takes Precedence (HTP with priority). Each source shall support assignment of priority to allow override of default HTP behavior.
    c. Each DMX port shall support its own universe and start address.
8. Gateways shall have built in DMX merger capability on a universe or channel-by-channel basis.
9. Gateways shall support have built in priority on a per-universe or channel-by-channel basis. Gateways that do not support prioritized merging of multiple network sources at independent priorities shall not be accepted.

H. DMX Connector Modules
1. Each gateway shall support up to four connector modules containing a single connector and its associated electronics
2. Connector module options shall include
    a. 5-pin Male DMX connector for DMX Input

b. 5-pin female DMX connector for DMX output
c. Eight position terminal connector for DMX input or output supporting screw terminals or Insulation displacement (IDC) wire terminations.

3. Each connector module shall be optically-isolated from the gateway electronics and from each other.
4. DMX connector modules shall be capable of withstanding fault voltages of up to 250vAC without damage.

I. Environmental
1. The ambient operating temperature shall be 0° to 40°C (32° to 104°F).
2. The storage temperature shall be -40° to 70°C (-40° to 158°F).
3. The operating humidity shall be 5% - 95% non-condensing.

J. Accessories
1. Hanging bracket kit shall allow unit to be mounted in three orientations
a. U-Bolt or C-Clamp mounting hardware shall be available
2. One E.I.A. rack space mounting bracket kit shall support either one or two complete units and allow for up to eight ports of DMX
3. Front Access Panel kit shall allow the connectors on the rear of the gateway to be accessed from the front of an equipment rack
4. A Universal Power Supply with international plug-set shall be available. Multiple power supplies shall be able to fit in a vertically stacked power strip.
5. ETC Gateway Configuration Editor Software (GCE)

K. System Requirements
1. Provide the quantity and type of gateways required, as scheduled. Gateways and software shall be as manufactured by Electronic Theatre Controls Inc. of MiddletonWI
2. Provide Ethernet switches and power supplies as scheduled and as shown on drawings.
3. Provide a current generation PC with Windows XP operating system equipped with a 10/100 Ethernet card.
4. Systems that do not provide the above capabilities shall not be acceptable

2.24 GENERAL NETWORK

A. General
1. The Electronic Theatre Controls Net3 network shall provide data distribution over TCP/IP Ethernet networks. Data shall be layer 3 routable. Systems using proprietary formats or formats other than 10/100/100Mbit wired Ethernet or non-layer 3 routable networks shall not be accepted.
2. Connections shall be made between consoles, face panels, architectural processors, dimmers, Net3 Gateways, and computers over standard Ethernet distribution systems using 100BaseT, 100BaseFL, or greater wiring. All installations shall conform to establish Ethernet wiring practice, and installation shall be performed by contractors qualified to do this type of work. All wiring shall be tested at Category 5e or higher for full bandwidth operation to the appropriate IEEE standard.
3. The Lighting Control system must be supplied by a single manufacturer and must have seamless integration over Ethernet between the Entertainment and Architectural lighting control.

B. Capacities
1. The network shall support DMX routing, patching, and prioritization for up to 63,399 universes (32,767,488 DMX addresses). Each address may be input or output from any port on any DMX gateway in the system. DMX input, routing and output shall be specifically supported on the system from multiple sources and locations up to the maximum number of gateways supported by the Ethernet topology.
2. The network shall support multiple network hosts including consoles, gateways, dimming racks, computers, file servers, printers, and architectural control processors with discrete command lines and control. The lighting network shall support multiple venues within a system and discrete systems on the same network.

C. System Configuration And Monitoring
1. Network device configuration shall be via Net3 Gateway Configuration Editor (GCE) software and/or ANSI E1.17 Architecture for Control Networks (ACN).
2. Patch addresses shall support viewing and manipulation via ANSI E1.17 ACN.

3. The system shall permit complete user flexibility allowing the system operator to patch each DMX input address to any ANSI E1.31 streaming ACN address, and DMX output to span streaming ACN universes.
4. The lighting system shall support assignment of DMX offsets, truncation of DMX universes, and provide choice of DMX port prioritization.
5. The lighting system shall support the DD start code extension to ANSI E1.31 which provides priority per address such that multiple control sources can share universes with discrete control per address.
6. Lighting systems that do not support the above mentioned address patching capabilities shall not be suitable.
7. The system shall allow assignable labels for all network devices to allow easy identification by system users.
8. Each network device shall have a discrete and unique IP address provided automatically by the software. The user may edit this IP address. Systems that do not support automated IP allocation with IP collision avoidance, and systems that do not allow complete reconfiguration of the above mentioned features over ANSI E1.17 ACN shall not be acceptable.
9. All configuration data for each network device shall be held at the device and system operation shall not require continuous on-line operation of the network configuration software.
10. Lighting console operators shall be able to backup the network configurations in the lighting control console. In the event of a network device failure, the operator shall be able to apply the configuration of the failed device to a replacement device of the same type without manually reentering settings. Systems that do not support configuration backup as described above shall not be accepted.
11. Architectural and Entertainment systems connected to the same network shall be capable of arbitrating control over E1.31 Streaming ACN (sACN) level data. The system shall be capable of alternating control of individual address data between architectural and entertainment systems without intervention by the user. The user shall dictate the conditions under which system shall automatically take control. The network shall allow user override of the selected defaults. Systems which require direct user intervention to allocate control of dimmers between architectural and entertainment lighting systems shall not be accepted.
12. The Net3 network shall allow multiple DMX input sources to be prioritized on the same universe as network native sources using E1.31 Streaming ACN prioritization. Multiple DMX inputs may be assigned to the same streaming ACN address (this provides multi-source control for a particular address). Likewise, the system shall support E1.31 prioritization of multiple simultaneous network sources. Systems that cannot prioritize multiple DMX inputs and multiple native network sources on a network shall not be deemed suitable.
13. The lighting network shall allow each DMX input address to be assigned a priority on the network allowing each DMX control level coming into the system to participate in full arbitration. Addresses with the highest priority shall have control, with lower priority addresses being ignored. Addresses assigned the same numeric priority, between 1 and 200, shall respond in highest level takes precedence (HTP) manor. The network shall require a valid DMX signal present at the input to initiate prioritization. Systems that do not allow for prioritized HTP for DMX inputs to the network shall not be allowed.

D. Operational Features
1. Each DMX gateway shall control up to 512 DMX addresses per port, within the confines of up to 63,999 DMX universes (32,747,488 address). The specific DMX data input or output by the gateway shall be configurable by the user.
2. Duplicate outputs of DMX data (DMX splitter) and discrete outputs shall be fully supported.
3. Merging of multiple DMX input sources on a single gateway without gateway with DMX output on the same gateway shall be supported without connection to the network. The gateway shall support assignment of priority to each input source independently
4. File transmission, synchronization and access to software shall be supported.

PART 3 - EXECUTION

3.1 INSTALLATION

A. It Shall Be The Responsibility Of The Electrical Contractor To Receive And Store The Necessary Materials And Equipment For Installation Of The Dimmer System. It Is The Intent Of These Specifications And Plans To Include Everything Required For Proper And Complete Installation And Operation Of The Dimming System, Even Though Every Item May Not Be Specifically Mentioned. The Contractor Shall Deliver On A Timely Basis To Other Trades Any Equipment That Must Be Installed During Construction.

B. The Electrical Contractor Shall Be Responsible For Field Measurements And Coordinating Physical Size Of All Equipment With The Architectural Requirements Of The Spaces Into Which They Are To Be Installed.

C. The Electrical Contractor Shall Install All Lighting Control And Dimming Equipment In Accordance With Manufacturers Approved Shop Drawings.

D. All Branch Load Circuits Shall Be Live Tested Before Connecting The Loads To The Dimmer System Load Terminals.

3.2 MANUFACTURER'S SERVICES

A. Upon Completion Of The Installation, Including Testing Of Load Circuits, The Contractor Shall Notify The Dimming System Manufacturer That The System Is Available For Formal Checkout.

B. Notification Shall Be Provided In Writing, Two Weeks Prior To The Time That Factory-Trained Personnel Are Needed On The Job Site.

C. No Power Is To Be Applied To The Dimming System Unless Specifically Authorized By Written Instructions From The Manufacturer.

D. The Purchaser Shall Be Liable For Any Return Visits By The Factory Engineer As A Result Of Incomplete Or Incorrect Wiring.

E. Upon Completion Of The Formal Check-Out, The Factory Engineer Shall Demonstrate Operation And Maintenance Of The System To The Owners Representatives. Training Shall Not Exceed Four Working Hours. Additional Training Shall Be Available Upon Request.

3.3 WARRANTY

A. Manufacturer Shall Warrant Products Under Normal Use And Service To Be Free From Defects In Materials And Workmanship For A Period Of Two Years From Date Of Delivery.

B. Warranty Shall Cover Repair or Replacement Of Such Parts Determined Defective Upon Inspection.

C. Warranty Does Not Cover Any Product Or Part Of A Product Subject To Accident, Negligence, Alteration, Abuse Or Misuse. Warranty Does Not Cover Any Accessories Or Parts Not Supplied By The Manufacturer.

D. Warranty Shall Not Cover Any Labor Expended Or Materials Used To Repair Any Equipment Without Manufacturer Prior Written Authorization.

END OF SECTION

NETWORK LIGHTING CONTROLS

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed. See luminaire schedule. Dimmable fixtures will be controlled through dimmable relays or wall box dimmers)

C. All system devices shall be networked together enabling digital communication and shall be individually addressable.

D. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.

E. The system architecture shall facilitate remote operation via a computer connection.

F. The system shall not require any centrally hardwired switching equipment.

G. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

H. Provide interface with Energy Management System specified under Division 23. Coordinate communication protocol with the HVAC building management system prior to ordering. The electrical contractor is responsible for making the wired connection between the BMS and the lighting controls system. The electrical contractor shall provide programming support to aid the hvac controls programmer in integrating the systems.

I. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 09 23 Lighting Control Devices.
   3. Section 26 09 33 Architectural Dimming Controls
   4. Section 26 27 26 Wiring Devices.
   5. Section 26 50 00 Lighting.

1.3 GENERAL REQUIREMNTS

A. Contractor shall price the network lighting control package separately from the light fixture package and shall provide a unit price breakdown of all components including all deducts (lot price and all-or-none). All pricing shall be transparent from the factory to the owner and all quotes shall be made available to the owner, architect or engineer upon request.

1.4 QUALITY CONTROL

A. The system shall be installed by a contractor experienced in the installation of lighting control systems. Provide a factory technician to supervise the installation and installation and make final adjustment and tests of the system.

B. All low voltage and communication wiring for the lighting control system shall be installed by a qualified and certified low-voltage installer within the electrical contractor’s company.

C. The system supplier shall furnish evidence of an experienced service organization which stocks system parts and is capable of providing repair service within 24 hours.

D. UL & ULc Approvals: The control panels shall be tested and listed under the UL 916 Energy Management Equipment standard and CSA C22.2 #205 by a nationally recognized testing laboratory.

E. NEC Compliance: The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.

F. NEMA Compliance: The control system shall comply with all applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.

G. Component Pre-testing: All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.

H. System Checkout: A factory trained technician or factory authorized personnel or contractor shall functionally test the control system and verify performance after installation.

I. Manufacturer shall have a minimum of 20 years of experience in control systems. Manufacturer shall provide off the shelf control products from its inventory. Control systems that require custom assembly and sizing shall not be acceptable.

J. The contractor is responsible for verifying compatibility of the network lighting control system with other lighting control devices as described in section 260926 Lighting Control Devices.

1.5 SUBMITTALS

A. Shop drawings: Submittal drawings with a complete system diagramed to show quantity of devices, location in the building, dimension and required wiring. For occupancy sensor, show the required quantity to cover the space controlled. Show the location of all relays for review by the owner and contractor.

B. Product data with wiring schematics for all system and user interface components as well as wiring diagrams for typical spaces in the building for review.

C. Installation and record drawings.

D. Operation and Maintenance Manuals: O&M manuals shall include product data of all system components, one line diagrams of all installed components and their locations throughout the building, a final floor plan noting the locations of devices installed above ceilings, behind access panels or in concealed but accessible spaces and the lighting zones or devices they control. Final relay schedule with the zone of control, location of control zone, voltage, power feed, time clock setting, photocell set point, switch or dimmer stations controlling the relay, and “sweep” function set points will be provided by the contractor.

1.6 SYSTEM OPERATION

A. The system shall use a modular component approach, utilizing a central processor, transceivers which activate relays and relay cabinets.

B. System shall incorporate the following criteria:
   1. All control information from the controller to the transceiver multiplexed over a single pair of wires.
   2. All control wiring shall conform to Article 725, Class 2 of the NEC.
   3. All components shall be standard catalog items available through electrical distributors.
   4. Expandable to control up to 4,000 relays. Relays operable from 2 or 3 or 4-wire control systems.
   5. Programmable on site to achieve all control functions and be readily updatable to reflect changes without requiring rewiring.

C. The installed system shall be capable of the following control functions:
   1. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
   2. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
   3. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches
   4. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.

5. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
6. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
7. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
8. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
9. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.
10. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
11. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
12. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
13. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.
14. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.
15. WiFi-enabled devices shall be capable of current monitoring
16. WiFi-enabled devices shall utilize WPA2 AES encryptio**n**
17. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks
18. WiFi-enabled devices shall have at least one local RJ-45 port for communicating with nonWiFi-enabled system devices
19. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.
20. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
21. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or WiFi backbone.
22. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.
    a. Auto-On / Auto-Off (via occupancy sensors)
        1) Zones with occupancy sensors automatically turn lights on when occupant is detected.
        2) Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
        3) Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.

b. Manual-On / Auto-Off (also called Semi-Automatic)

1) Pushing a switch will turn lights on.
2) Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

c. Manual-On to Auto-On/Auto-Off

1) Pushing a switch will turn lights on.
2) After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
3) Sequence can be reset via scheduled (ex. daily each morning) events

d. Auto-to-Override On

1) Zones with occupancy sensors automatically turn lights on when occupant is detected.
2) Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
3) Sequence can be reset via scheduled (ex. daily each morning) events

e. Manual-to-Override On

1) Pushing a switch will turn lights on.
2) Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
3) Sequence can be reset via scheduled (ex. daily each morning) events

f. Auto On / Predictive Off

1) Zones with occupancy sensors automatically turn lights on when occupant is detected.
2) Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
3) If switch is pressed, lights turn off and a short “exit timer” begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.

g. Multi-Level Operation (multiple lighting levels per manual button press)

1) Operating mode designed specifically for bi-level applications
2) Enables the user to cycle through the up to four potential on/off lighting states using only a single button.
3) Eliminates user confusion as to which of two buttons controls which load
4) Three different transition sequences are available in order to comply with energy codes or user preference)
5) Mode available as a setting on all nLight devices that have single manual on/off switch (ex. nWSX, nPODM, nPODM-DX).
6) Depending on the sequence selected, every button push steps through relays states according to below table
7) In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to “step” in a sequence that achieves bi-level operation is present.

h. A taskbar style desktop application shall be available for personal lighting control.
i. An application that runs on “smart” handheld devices (such as an Apple® IPhone®) shall be available for personal lighting control.
j. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

k. Control software shall enable integration with a BMS via BACnet IP.
l. System shall provide the option of having pre-terminated plenum rated CAT-5 cabling supplied with hardware.

1.7 CONNECTION TO NETWORK

A. General: Communication between all peer-to-peer network lighting control panels shall be via TCP/IP over existing Ethernet, RS-485, RS-232 and other previously established panel system communication protocol.

B. Provide BacNet backbone on all lighting control panels

C. Provide all software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sensorswitch n-Light

B. Note: all control for this building will be provided by the 4j school district inless specifically noted on plans. The n-light system is for designated areas only. For classrooms, LEV-LOK switches are to be provided. Overide switches in select locations are to be illuminated LEV-LOK switches. Verify locations with 4j prior to ordering. Provide a timer switch in the custodial closet spaces.

2.2 LIGHTING CONTROL EQUIPMENT

A. Control Module (Gateway)
1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.
2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
7. Device shall have a USB port
8. Each control gateway device shall be capable of linking 1500 devices to the management software.
9. Device shall be capable of using a dedicated or DHCP assigned IP address.
10. Network Control Gateway device shall be the following Sensor Switch model Series or equivalent from the manufacturers selected:
nGWY2

B. Networked System Occupancy Sensors
1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology or Ultrasonic technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics and PIR/Ultrasonic.
5. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.
6. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.

7. Sensors shall be available in multiple lens options which are customized for specific applications.
8. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
9. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
10. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
11. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
12. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
13. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
14. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
15. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
16. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.
17. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
18. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls
19. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
20. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection
21. Embedded sensors shall have an optional photocell
22. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
23. Fixture mount sensors shall be capable of powering themselves via a line power feed.
24. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
25. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).

C. Networked System Daylight (Photocell and or Dimming) Sensors
1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).
5. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.
9. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.

D. Networked System Power (Relay) Packs
1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
7. Power Packs and Power Supplies shall be available that are WiFi enabled.
8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.
9. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.
11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
12. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
13. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
14. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.
15. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.
16. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
17. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
18. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

E. Networked System Relay & Dimming Panels
1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.

5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection

F. Networked Auxiliary Input / Output (I/O) Devices
1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
7. Specific I/O devices shall sense state of low voltage outdoor photocells
8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
9. Specific I/O devices shall sense .

G. Networked System Wall Switches & Dimmers
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Devices shall be available with zero or one integrated Class 1 switching relay.
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. All sensors shall have two RJ-45 ports.
5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
7. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).
8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.
9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
10. Devices with mechanical push-buttons shall be made available with custom button labeling
11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
12. Wall switches & dimmers shall be the following, with device options as specified:
    (single on/off, capacitive touch, audible user feedback)
    (dual on/off, capacitive touch, audible user feedback)
    (single on/off, one relay, capacitive touch, audible user feedback)
    (single on/off, push-buttons, LED user feedback)
    (dual on/off, push-buttons, LED user feedback)
    (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
    (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
    (quad on/off, push-buttons, LED user feedback)
    (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

H. Networked System Graphic Wall Station
1. Device shall have a 3.5" full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.
2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
3. Device shall enable user supplied .jpg screen saver image to be uploaded.

4. Device shall surface mount to single-gang switch box
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Device shall have two RJ-45 ports for communication
7. Device shall be the following Sensor Switch model number or equal by one of the manufacturer's listed above:
   nPODGFX

I. Networked System Scene Controllers
1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Device shall recess into single-gang switch box and fit a standard GFI opening.
3. Devices shall provide LED user feedback.
4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
5. All sensors shall have two RJ-45 ports.
6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
7. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
8. Device shall have LEDs indicating current selection.
9. Scene Selector device shall be the following:
   (2 Scene, push-button)
   (4 Scene, push-button)
   (4 Scene, push-button, On/Off/Raise/Lower)
   (4 Adjustable Presets, push-button, On/Off/Raise/Lower)

J. Communication Bridges
1. Device shall surface mount to a standard 4" x 4" square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

K. RS-232 port
1. The controller shall provide an RJ-12 connection for RS-232 communications. Programming shall be permitted through either a local connection or remotely through a modem. The Keeper Enterprise software accessory includes a six wire communication cable to connect to the controller. Systems that do not include an on-board RS232 port for communications are not acceptable.

L. Memory Back-up
1. The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in Flash Memory shall be protected against power interruptions for the life of the product. The power interrupt protection circuit shall be entirely maintenance-free.

2.3 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Prior to timed "sweep" off functions, the system will blink-warn by briefly turning the lights on and off once 5 minutes prior to the sweep off function being executed.

Q. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.4 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics/Ultrasonic Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.5 BMS COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

D. It is the responsibility of the electrical contractor to make all hard wired and wireless connections to the BMS and coordinate programming with the BMS programmer.

2.6 SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An “Energy Scorecard” shall be display that shows calculated energy savings in dollars, KWHr, or CO_2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file

2.7 START-UP & SUPPORT FEATURES

A. Test at least 10% of all low voltage wiring and low voltage control devices for wiring continuity prior to commissioning of the lighting control system.

B. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

C. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

D. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

E. All system devices shall be capable of being given user defined names.

F. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

G. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

PART 3 - EXECUTION

3.1 DRAWINGS

A. The Installation and Record Drawings called for under submittals shall consist of reproducible drawings with all outlets, devices, terminal cabinets, conduits and wiring shown. Prints of these drawings shall be submitted for approval prior to starting installation. Upon request, the Architect will furnish reproducible floor plans as required for the contractor’s use in developing the Installation and Record Drawings.

B. The contractor submitted drawings when approved, will then form the basis for installation.

C. At the completion of the work all deviations from the installation drawings shall be incorporated on the reproducibles to indicate “as built” conditions. The drawings will then be submitted as Record Drawings for the system.

3.2 INSTALLATION

A. Install systems for each section of each floor and connect lighting circuits per relay schedule on drawings. Prior to istalltion, coordiante the location of all relays with the architect and owner and provide a detailed map of relay locations for the owner as part of the O&M documents.

B. Area control switches shall be able to manually provide 2-level control of lights by area.

C. Provide conduit for all wiring, 1/2 inch minimum size.

D. Components for cabinets shall be factory installed.

3.3 INSTRUCTION

A. Without additional expense to the Owner, competent authorized representative personnel shall give instruction for the care, adjustment, and operation of all parts of the system to the Owner's Authorized Representative who is to have charge of the equipment.

B. Each instructor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as in practical operation and system maintenance.

C. Furnish 16 hours of instruction after final acceptance of the system at the dates and times selected by the Owner.

D. Installation, start-up, and maintenance assistance shall be available from the manufacturer on an as-needed basis.

E. Digitally record video and audio of all training and provide a copy in Mpeg, AVI or similar format to the owner after training on a CD, portable drive or via web link.

END OF SECTION

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 1 Specification Sections, apply to this Section.

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Provide dry type transformers to provide 208Y/120V power from the 480Y/277V system.
   2. Size transformers as indicated.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   3. Section 26 05 33 Raceways and Boxes for Electrical Systems.
   4. Section 26 05 53 Identification for Electrical Systems.
   5. Section 26 05 80 Electrical Testing.

1.3 SUBMITTALS

A. Shop drawings with nameplate data.

B. Product data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Transformers shall be of the same manufacturer as the distribution equipment specified in Section 26 24 13; or approved equivalent.

2.2 INDOOR LOW VOLTAGE TRANSFORMERS

A. Enclosed and ventilated, air cooled dry-type, Class H insulation, NEMA type TP-1. Equip with two 2-1/2% FCAN taps and four 2-1/2% FCBN taps. Maximum sound level shall be N.E.M.A. standard with vibration isolators between the core and coil assembly and case.

B. Maximum sound level shall be NEMA standard with vibration isolators between the core and coil assembly and case. There shall be no metal-to-metal contact between core and coil and the enclosure. Sound levels shall be warranted by the manufacturer not to exceed the following:

10 to 50 KVA	45 DB
51 to 150 KVA	50 DB
151 to 300 KVA	55 DB
301 to 500 KVA	60 DB
501 to 700 KVA	62 DB

C. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC Standards.

D. The case shall be totally enclosed with louvers to prevent entry of foreign objects into the interior, manufactured in accordance with all NEMA & UL approval standards.

E. Provide grounded isolation shields between the primary and secondary windings where noted or shown on the Drawings to attenuate source of line interference. Insulate shield from the transformer windings and core and ground to transformer enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install transformers with flexible conduit connections to housing. Make all cable and ground wire connections.

B. In general, transformers will be floor mounted. When necessary to wall or trapeze mount, securely anchor to structure as required for seismic zone 3.

C. Install with sound isolating vibration dampers between the transformer enclosure and the hanger or building structure.

D. Provide nominally 3-inch deep concrete pads under all floor-mounted transformers.

E. Provide seismic restraint for all transformers as recommended by SMACNA. Provide shop drawings sealed by a registered Structural Engineer indicating this seismic restraint.

END OF SECTION

SWITCHBOARDS

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Provide the materials for the complete secondary service and distribution system as indicated.
   2. Provide a transformer pad and ground grid for use by the serving utility. Coordinate pad size, openings, type of construction, conduit arrangement and grounding requirements with the utility prior to construction.
   3. Provide utility metering facilities where indicated on the Drawings, complying with the established serving utility requirements. Provide quantity and style of meter sockets and accessories required by the utility.
   4. Include all metering charges or connection costs charged by the serving utility in the original proposal. Refer to Coordination of Work section of these Specifications.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   3. Section 26 05 53 Identification for Electrical Systems.
   4. Section 26 05 73 Overcurrent Protective Device Coordination Study.
   5. Section 26 05 80 Electrical Testing.

1.3 SUBMITTALS

A. Shop Drawings.

B. Product data:
   1. Detailed component material list.
   2. Voltage rating, amperage rating, bussing material, fault rating, wiring lugs capacity, mounting method, physical size, exterior finish and options.
   3. Equipment one-line diagram.
   4. Equipment elevations and dimensions.
   5. Conduit entry areas.
   6. Individual circuit breaker product data sheets.
   7. Panel schedules; the panel schedules shall indicate circuit breakers in the same orientation as the construction documents.

C. Equipment test reports.

D. Operation and Maintenance data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Eaton, General Electric, Siemens, or Square D.

2.2 MAIN DISTRIBUTION PANEL (MDP)

A. General:
   1. NEMA Standard PB-2 and UL 891 compliant.
   2. Freestanding, rear-aligned, front-accessible, group-mounted circuit breaker type, fully enclosed with bussing and hardware provisions for the addition of future circuit breakers.
   3. Circuit breaker trip ratings shall be as indicated on Drawings.
   4. Equipment assembly shall have a short circuit current rating (SCCR) greater than the maximum available fault current expected at that point in the distribution system.
   5. Panel shall be listed by Underwriters' Laboratories and shall bear a UL label as suitable for use as service equipment.
   6. Refer to Drawings for maximum allowable equipment footprint.

B. Construction:
   1. Equipment shall consist of the required number of vertical sections bolted together to form a rigid assembly.
   2. All edges of front covers or hinged front panels shall be formed.
   3. Provide adequate ventilation within the enclosure.
   4. All sections of the equipment shall be rear-aligned with depth as required to accommodate devices shown and necessary conduit entrance for current and future devices.
   5. All exterior and interior steel surfaces shall be properly cleaned and provide with a rust-inhibiting coating. Color and finish shall be ANSI 61 light gray.

C. Bus Work:
   1. Copper or tin-plated aluminum, sized as indicated on Drawings, with a 100% capacity neutral bus.
   2. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C above an ambient of 40°C under continuous full load current and rated to withstand the maximum available fault current expected at that point in the distribution system.
   3. Include bussing provisions for mounting future devices in all spaces called for on Drawings. Where configuration provides additional spaces within a section, these spaces shall be bussed to receive future devices.
   4. Future Kirk Key Generator Tie Connection: Provide bussing provisions and connection lugs in a dedicated section for future generator circuit breaker tie input, including provisions for underground conduit entry. Provide main circuit breaker (utility power input) with Kirk Key interlock installation provisions.
   5. Provide a copper ground bus firmly secured to each vertical section and extending the entire length of the MDP.
   6. All vertical sections shall be fully bussed.

D. Provide separate vertical section for service entrance conductor drip loop when Main Distribution Panel is installed below finished grade or when susceptible to water intrusion via service conduit. Contractor shall install drip loop per serving utility requirements, if applicable.

E. Utility Metering: Where indicated on Drawings, provide a separately barriered Utility Metering Compartment complete with hinged sealable door in accordance with Utility requirements. Bus work shall include provisions for mounting utility company current transformers and potential transformers or potential taps as required by the utility company.

F. Circuit Breakers:
   1. Provide main and feeder circuit breakers as shown on Drawings.
   2. Circuit breakers shall be molded case, bolt-on type, with inverse time and instantaneous tripping characteristics.
   3. Provide with ground fault protection where indicated on Drawings or as required by NEC.
   4. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position.

5. Circuit breakers shall have short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for any circuit breaker shall be 10,000 AIC for 120/208V breakers, and 14,000 AIC for 277/480V breakers.
6. Space and Future Provisions: Provide full height main bussing with (1) 400A/3-pole and (4)225A/3-pole circuit breaker space provisions, unless otherwise noted on the plans.
7. Series rating is not permitted.

G. Wiring/Terminations:
1. Small wiring, necessary fuse blocks and terminal blocks within the MDP shall be furnished as required. Control or metering components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75°C of the size as indicated on the Drawings.
3. Lugs shall be provided in the incoming line section for connection of the main grounding conductor and other grounding conductors as indicated on Drawings.

H. Where exposed to weather, provide NEMA Type 3R enclosure with interior thermostatically controlled electrical space heater with adequate wattage to prevent the accumulation of moisture. Power for space heater shall be obtained from a control power transformer within the MDP assembly.

I. Surge Protection Device (SPD):
1. SPD shall be mounted in a NEMA Type 1 enclosure external to switchboard equipment.
2. Surge protection shall use thermally protected MOV technology.
3. Surge current capacity rating shall be as recommended by manufacturer.
4. Dual-colored protection status indicators for each phase.
5. Dual-colored protection status indicators for the N-G protection mode.
6. Audible alarm with silence button.
7. Form C relay contact.

J. Electronic Customer-Metering:
1. Provide microprocessor based electronic meter to monitor electrical power distribution system in a real time mode. The system shall consist of a meter and display integral to the MDP in a separate customer-metering compartment with front-hinged door.
2. At a minimum, a meter shall be provided for the incoming electrical service. Where shown on Drawings, provide additional meters for other equipment and feeder devices within Main Distribution Panel.
3. Where multiple meters are required, provide single LCD display capable of accepting inputs from all meters shown.
4. Current transformers for each meter shall be wiring to shorting-type terminal blocks within customer metering compartment.
5. Potential transformers including primary and secondary fuses with disconnecting means shall be provided.
6. The electronic meter shall accept input from industry standard instrument transformers (120VAC secondary PT's and 5A secondary CT's.)
7. The current and voltage signals shall be digitally sampled at a rate high enough to provide accurate RMS sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental frequency of 60 HZ).
8. All setup parameters required by the meter shall be stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.
9. The meter shall also maintain in nonvolatile memory a maximum and minimum value for each of the instantaneous values reported as well as the time and date of the highest peak for all of the peak demand readings.
10. The meter shall be accurate to +1.0% voltage and current sensing.

11. The following minimum readings shall be reported by the meter:
    a. Energy: real (kWh), reactive (kVARh).
    b. Current, per phase RMS +1.0%.
    c. Current, 3-phase average RMS +1.0%.
    d. Voltage, phase-to-phase and phase-to-neutral +1.0%
    e. Power factor, per phase +2.0%.
    f. Power factor, 3-phase total +2.0%.
    g. Frequency +0.5%.
12. The following demand readings shall be reported by the meter:
    a. Average demand current, per phase.
    b. Peak demand current, per phase.
13. Communications: Provide with RS-485 and Modbus RTU output capability.

2.3 SUB-DISTRIBUTION PANELS (SDP)

A. General:
1. Similar in manufacture as the Main Distribution Panel.
2. Freestanding, rear-aligned, front-accessible, group-mounted circuit breaker type, fully enclosed with bussing and hardware provisions for the addition of future circuit breakers. Assemblies rated 800Amps or below may be wall-mounted.
3. Circuit breaker trip ratings shall be as indicated on Drawings.
4. Equipment assembly shall have a short circuit current rating (SCCR) greater than the maximum available fault current expected at that point in the distribution system.
5. Panel shall be listed by Underwriters' Laboratories and shall bear a UL label.
6. Refer to Drawings for maximum allowable equipment footprint.

B. Construction:
1. Equipment shall consist of the required number of vertical sections bolted together to form a rigid assembly.
2. All edges of front covers or hinged front panels shall be formed.
3. Provide adequate ventilation within the enclosure.
4. All sections of the equipment shall be rear-aligned with depth as required to accommodate devices shown and necessary conduit entrance for current and future devices.
5. All exterior and interior steel surfaces shall be properly cleaned and provide with a rust-inhibiting coating. Color and finish shall be ANSI 61 light gray.

C. Bus Work:
1. Copper or tin-plated aluminum, sized as indicated, with a 100% capacity neutral bus.
2. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C above an ambient of 40°C under continuous full load current and rated to withstand the maximum available fault current expected at that point in the distribution system.
3. Include bussing provisions for mounting future devices in all spaces called for on Drawings. Where panel configuration provides additional spaces within a section, these spaces shall be bussed to receive future devices.
4. Provide a copper ground bus firmly secured to each vertical section and extending the entire length of the SDP.
5. All vertical sections shall be fully bussed.
6. Space and Future Provisions: Provide full height main bussing with (1) 400A/3-pole and (4)225A/3-pole circuit breaker space provisions, unless otherwise noted on the plans.

D. Circuit Breakers:
1. Provide main and feeder circuit breakers as shown on Drawings.
2. Circuit breakers shall be molded case, bolt-on type, with inverse time and instantaneous tripping characteristics.
3. Provide with ground fault protection where indicated on Drawings or as required by NEC.
4. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position.

5. Circuit breakers shall have short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for any circuit breaker shall be 10,000 AIC for 120/208V breakers, and 14,000 AIC for 277/480V breakers.
6. Series rating is not permitted.

E. Wiring/Terminations:
1. Small wiring, necessary fuse blocks and terminal blocks within the SDP shall be furnished as required. Control or metering components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75°C of the size as indicated on the Drawings.
3. Lugs shall be provided in the incoming line section for connection of the main grounding conductor and other grounding conductors as indicated on Drawings.

F. Where exposed to weather, provide NEMA Type 3R enclosure with interior thermostatically controlled electrical space heater with adequate wattage to prevent the accumulation of moisture. Power for space heater shall be obtained from a control power transformer within the SDP assembly.

G. Surge Protection Device (SPD):
1. SPD shall be mounted in a NEMA Type 1 enclosure external to SDP equipment.
2. Surge protection shall use thermally protected MOV technology.
3. Surge current capacity rating shall be as recommended by manufacturer.
4. Dual-colored protection status indicators for each phase.
5. Dual-colored protection status indicators for the N-G protection mode.
6. Audible alarm with silence button.
7. Form C relay contact.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the distribution system assemblies and equipment as shown on the Drawings, parallel and square with the building lines.

B. Attach all distribution equipment to building structure; refer to Section 260529.

C. Neatly lace and secure the conductors of the feeder circuits individually at maximum 2-foot intervals. The cable lugs shall not support the weight of the cables.

D. Where fusible distribution panels are provided, mount a spare fuse cabinet adjacent to each fusible distribution panel. Equip cabinet with one complete set of spare fuses of each size and type installed in the panel with appropriate fuse pullers.

E. Concrete Pads: Provide minimum 3.5-inch thick concrete housekeeping pads under all freestanding pieces of distribution equipment. Pads shall extend a minimum of 2-inches beyond the edges of the equipment.

F. Adjust breaker settings per recommendation of coordination study and test all ground fault settings as required by NEC.

G. Equipment Tests:
1. Acceptance testing shall be provided for all equipment in accordance with NETA Acceptance Testing Specifications. Record results and submit with final warranty.
2. Where ground fault protection is provided, perform tests on the ground fault protection system in accordance with the manufacturer's instructions. Record results and submit with final warranty.

3. If any tested equipment is found defective during testing sequence, the contractor shall replace it without any additional cost to the Owner. All replaced equipment shall be tested until satisfactory results are obtained.
4. Where included, refer to Section 26 05 80 for additional requirements.

H. Cleaning: Upon completion of installation, inspect interior and exterior of distribution equipment. Remove paint splatters or other spots. Vacuum dirt and debris; do not use compressed air to clean. Repair exposed surface to match original finish.

END OF SECTION

PANELBOARDS

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 provisions of Division 26 Section Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes: Provide panelboards for branch circuit distribution as indicated.

B. Related Sections include:
1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
3. Section 26 05 33 Raceways and Boxes for Electrical Systems.
4. Section 26 05 53 Identification for Electrical Systems.
5. Section 26 05 73 Overcurrent Protective Device Coordination Study.
6. Section 26 05 80 Electrical Testing.

1.3 SUBMITTALS

A. Shop drawings.

B. Product data.
1. Detailed component material list.
2. Voltage rating, amperage rating, bussing material, fault rating, wiring lugs capacity, mounting method, physical size, exterior finish and options.
3. Individual circuit breaker product data sheets.
4. Panel schedules; the panel schedules shall indicate circuit breakers in the same orientation as the construction documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Panelboards shall be of the same manufacturer as the distribution equipment specified in Section 26 24 13.

2.2 BRANCH PANELBOARDS

A. Branch Circuit Panels: Bolt-on circuit breaker type fitted with metallic flush lift latches and locks keyed alike. Deliver all panel keys to the Owner at completion of the project.

B. Short Circuit Current Rating (SCCR): Fully rated at a value greater than the maximum available short circuit current that can be expected at the panelboard location in the electrical system. Series rating is not permitted.

C. Cabinets:
1. Cabinet rough-in boxes shall be code gauge steel, with dead front covers.
2. Flush panels shall have flush doors with concealed hinges and mounting clamps.Surface panels shall have metal face trims with no sharp edges or corners. Surface panel cabinets shall be fabricated without knockouts and finished to match face trim.
3. All panels shall have hinged trim fronts with captive screws that provides full access to wiring compartment.

D. Wiring Gutters: A minimum of 4-inches wide except where feeder conductors enter where a minimum of 6-inches clear shall be provided. Feeder conductors to enter directly in line with lug terminals wherever practicable. Provide separate feeder studs for each feeder conductor compression lug.

E. Bussing: Provide one continuous bus bar per phase. Provide copper or electrical grade aluminum alloy sized as indicated on the drawings and in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65°C above an ambient temperature of 40°C maximum. Full size insulated neutral bars shall be included for panels indicated to have a neutral. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices.

F. Ground Bus: Provide in each panelboard. Ground bus shall:
1. Have the same rating as the neutral bus.
2. Contain a ground conductor terminal for each available circuit in the panelboard.
3. Have terminals sized for the branch circuit equipment grounding conductors.

G. Isolated Ground Bus: Provide in each panelboard as indicated. Ground bus shall:
1. Be insulated from the panelboard enclosure.
2. Have the same rating as the neutral bus.
3. Contain a ground conductor terminal for each available circuit in the panelboard.
4. Have terminals sized for the branch circuit equipment grounding conductors.

H. Interiors: Main lug only unless otherwise indicated, with dead front shield covering the bus, and bus connectors, with all mounting hardware and bussing for all spaces indicated for future installation of devices. Interior trim shall be of dead front construction. All unused mounting spaces shall be covered with preformed knockouts.

I. Main Circuit Breaker: Where indicated, equip panels indicated with main circuit breakers sized as scheduled and mounted behind door at top of panel for top entrance feeders, and bottom of panel for bottom entrance feeders. Where main circuit breaker size is not indicated, ampere rating shall match feeder ampacity or panelboard rating, whichever is less.
1. Molded case, thermal magnetic bolt-on type and sized as indicated on the Drawings. Circuit breaker shall have an overcenter, trip-free, toggle mechanism that shall provide quick-make, quick-break contact action. Indicate open, closed, or tripped by handle position, with common internal trip crossbar to provide simultaneous tripping for all poles.
2. Circuit breakers shall have a permanent trip action with thermal and magnetic trip elements in each pole. Each thermal element shall be factory calibrated to operate in a 40°C ambient environment. Thermal elements shall be ambient compensating above 40°C.
3. Provide with circuit breaker lock-off device to provide capability to be locked in the open position.

J. Branch Circuit Breakers:
1. Breakers shall be provided with amperage rating, and number of poles as indicated in the Panelboard Schedules.
2. Circuit breakers shall be bolt-on type.
3. Circuit breakers shall have an overcenter toggle mechanism that shall provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping.
4. The exposed faceplates of all circuit breakers shall be flush with one another.
5. Breakers shall have short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for any circuit breaker: 10,000 A.I.C. for 120V and 208V breakers, 14,000 A.I.C. for 277V and 480V breakers unless otherwise noted on drawings.
6. Circuit breakers used for switching duty shall be UL listed for that purpose and marked "SWD".

7. Circuit breakers serving heat trace circuits shall be ground fault interrupter (GFI) type with 30 ma ground fault trip rating.
8. Provide circuit breaker lock-off device for each branch circuit breaker
9. Space and Future Provisions: For distribution panels, provide minimum (2)225A/3-pole and (2)100A/3-pole circuit breaker space provisions, unless plans describe greater provisions. For branch panels, provide minimum (6)20A/3-pole circuit breaker space provisions, unless plans describe greater provisions.

K. Provide shunt trips, alarms and auxiliary switches as shown on the Drawings.

L. Proved Arc Fault Circuit Interrupter (AFCI) breakers as shown on the Drawings or as required by Code.

2.3 IDENTIFICATION

A. Branch circuit breakers shall be identified with individual circuit numbers adjacent to each breaker with a typewritten card to identify the load controlled by that breaker.

B. Contractor will be provided with complete schedules of all panelboards as designed prior to start of construction. Schedules will include circuit breaker arrangement, load schedules, and ratings for use in identification of circuits and coordination.

C. Refer to Section 26 05 53 Identification of Electrical Systems for additional requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's recommendations.

B. Install panelboards plumb and level, located as shown on the Drawings up 6-feet – 6-inches to top unless noted otherwise.

C. Area above panelboard shall be kept clear of all equipment foreign to the electrical installation including piping, ductwork, supports, etc. Coordinate installation with all other trades.

D. Provide identification as specified in Section 26 05 53 Identification of Electrical Systems.

3.2 SPARE CONDUITS

A. Install a spare 3/4-inch conduit from flush panels for each three single pole breakers or spaces provided. Terminate conduits above accessible ceiling or as directed.

END OF SECTION

WIRING DEVICES

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes: Wiring devices and plates for all outlet boxes shown.

B. Related Sections include:
1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
3. Section 26 05 33 Raceways and Boxes for Electrical Systems.
4. Section 26 05 53 Identification for Electrical Systems.
5. Section 26 05 80 Electrical Testing.

1.3 SUBMITTALS

A. Product data.

B. Shop drawings of the occupancy sensor locations shall be prepared by the manufacturer in AutoCAD and submitted for review. The shop drawings shall be coordinated with all other trades and identify actual device locations and quantities within each space required to provide adequate sensing coverage in accordance with manufacturer's recommendations. Identify mounting configuration (i.e. ceiling or wall) and sensor technology proposed at each location.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wiring devices shall be extra heavy duty grade, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed herein , such device shall be of same grade and manufacture as specified below. Furnish a matching plug connector for all special purpose devices that do not have the common 120 volt NEMA 5-20R configuration.

B. All lighting switches and duplex receptacles installed shall have similar appearance characteristics unless noted otherwise.

2.2 WALL SWITCHES

A. Acceptable Manufacturers: Leviton "Lev-Lok" or approved equal.

B. Line Voltage Switches: 20 amp rated, 277 volt, quiet type, extra heavy duty, heavy duty nylon toggle handle, .
1. As noted on the drawings provide:
   a. Pilot light switch: lighted clear toggle.
   b. Momentary Contact Switches: 15A, SPDT, center off.
   c. Key Switches: 20 ampere, 277V, back and side wired with screw terminal connections.

C. EPO pushbutton switch: Red mushroom head push-off, pull-on with concentric guard, 2-1/4 inch diameter, non-illuminated, heavy duty operator. Provide clear hinged louver to prevent accidental operation. Provide laminated engraved nameplate attached with stainless steel screws indicating "Emergency Power Off" and load served.

D. Dimming Switches: architectural grade, line voltage, 20 amp rated, single pole, slide-to-off type, slide up to brighten and down to dim, decora style, wattage rating and lamp/ballast compatibility as required. Provide 3-way type where shown on plan. Lutron Nova T, Leviton SureSlide, or Hubbell.

E. Except as noted herein, device exposed finish color shall be as follows:
   1. Normal power: Gray or as selected by Architect.
   2. Emergency power: Red.
   3. Standby power: Red.

2.3 SENTRY SWITCHES

A. Acceptable Manufacturers: Sentry Switch, LLC or approved equal.

B. 20 amp rated, 277 volt heavy duty nylon toggle handle, back and side wired with screw terminal connections

C. Mechanically resets to “off” when input power is interrupted for 5 seconds or longer, mini neon indicator light that illuminates when unit is switched off.

2.4 RECEPTACLES

A. Acceptable Manufacturers: Leviton “Lev-Lok” or approved equal.

B. Standard straight blade duplex receptacle: 3-wire, 2-pole with grounding, extra heavy duty, 10 amp rated, NEMA 5-20R configuration,.

C. Ground Fault Interrupting straight blade duplex receptacle: heavy duty, 3-wire, 2 pole with grounding, self-testing, green “ON” LED to indicate power, red “ON” LED to indicate ground fault condition, 20 amp rated, NEMA 5-20R configuration, .
   1. Provide weather-resistant rating at exterior locations as required by NEC.

D. Special Purpose Receptacles: As noted on Drawings with NEMA configurations.

E. Except as noted herein, device exposed finish color shall be as follows:
   1. Normal power: Gray or as selected by Architect.
   2. Emergency power: Red.
   3. Standby power: Red.

2.5 PLATES

A. Acceptable Manufacturers: Hubbell, Leviton, Arrow-Hart, Pass & Seymour.

B. Flush Finish Plates: 0.040" thick, type 302 stainless steel, brush finish**.** Surface Covers: Galvanized or cadmium plated steel, 1/2" raised industrial type with openings appropriate for device installed.

C. Weatherproof: Extra-Duty while in use covers, UL 514D listed, commercial quality diecast aluminum construction, NEMA 3R rated, gasketed, built-in padlock provisions, built-in cord strain relief provisions, gray powder-coated finish, vertical mounting as required for application or other covers of similar construction for other receptacle configurations.

D. Identification: Identify receptacle plates with a pre-printed label indicating serving panel and branch circuit number. Refer to 260553 Identification for Electrical Systems.

2.6 OCCUPANCY SENSORS

A. Acceptable Manufacturers: Watt Stopper, Leviton, SensorSwitch, Hubbell or Lutron. Watt Stopper series numbers are indentified herein to establish the minimum level of quality for each product. Comparable products that meet the requirements of the specification by other acceptable manufacturers identified herein are acceptable.

B. Wall-box Mounted: Passive infrared type, 180 degree coverage, automatic-on operation, 3-wire type, daylight override, adjustable time-out, selectable walk-through mode and override off switch. Single or dual relay type as required or as shown on Drawings. Watt Stopper #PW series.

C. Ceiling Mounted: 360 degree coverage, automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode, low- or line-voltage as shown on Drawings or described herein, surface mounted, with power pack as required, provide auxiliary contacts.
   1. Combination passive infrared and ultrasonic/microphonic type: Watt Stopper #DT-300 series.
   2. Passive infrared type: Watt Stopper #CI-300 series.
   3. Ultrasonic type: Watt Stopper #UT-300 series.

D. Ceiling/Wall Mounted: 180 degree coverage, automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode, low-voltage with power pack, surface mounted, provide auxiliary contacts.
   1. Combination passive infrared and ultrasonic/microphonic type: Watt stopper #DT-200 series.
   2. Passive infrared type: Watt stopper #CX-100 series.

E. Provide all ceiling mounted occupancy sensors with isolated normally open and normally closed output contacts rated at 1A at 30VDC/VAC. Coordinate interface requirements with HVAC contractor.

F. Provide multiple contacts and/or power packs for occupancy sensors that:
   1. Control both normal and emergency lighting and require separation of branch circuit wiring systems. In case of occupancy sensor failure, emergency lighting shall fail to the “on” state.
   2. Control separate lighting control zones. Unless otherwise noted, occupancy sensors are intended to control all light in a designated zone or room. Contractor is responsible for providing the required power packs to insure functionality of the system.

2.7 LIGHTING CONTROL RELAYS

A. Normal Lighting: Functional Devices, Inc – RIBMW24B-44-BC

B. Emergency Lighting: Functional Devices, Inc – ESRM2401B

PART 3 - EXECUTION

3.1 INSTALLATION

A. Devices and finish plates to be installed plumb with building lines. Wall mounted receptacles shall be installed vertically at centerline height shown on the Drawings.

B. Finish plates and devices are not to be installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.

C. Switches, receptacles and/or other devices ganged into a common enclosure shall be provided with a separation barrier between devices where the combined circuit voltages within the enclosure exceeds 300 volts.

D. Provide GFCI receptacles as shown on the drawings or as NEC required. Provide a GFCI type duplex receptacle in each required location, do not sub-feed normal receptacles downstream of the GFCI receptacle to obtain the GFCI rating.

E. Provide receptacles with GFCI, tamperproof, weather-resistant or hospital grade ratings as shown on the drawings, appropriate for the installation or required by NEC.

3.2 CORD CAPS

A. All special plugs provided with the receptacles shall be given to the Owner in their cartons with a letter stating the date and the Owner’s representative that received the materials.

3.3 COORDINATION

A. The Electrical Drawings indicate the approximate location of all devices. Refer to Architectural elevations, sections and details for exact locations.

B. Coordinate with equipment installer the locations and methods of connection to devices mounted in cabinets, counters, work benches, service pedestals and similar equipment.

C. Installation height of lighting controls and receptacles shall conform to the most recent ADA Standards for accessibility requirements. Standard receptacle height shall be 15” above finished floor to bottom of junction box, and standard switch height shall be 48” above finished floor to top of junction box, unless otherwise noted or as otherwise required by ADA Standards. Refer to Architectural requirements for installation of devices above/below countertops and within casework. Architectural requirements for dimensional locations of device rough-ins shall govern.

3.4 OCCUPANCY SENSORS

A. Line voltage occupancy sensors shall be provided when installed in inaccessible ceiling system, except when auxiliary contacts are required, in which case a low voltage occupancy sensor shall be provided. For installation of low voltage occupancy sensors in inaccessible ceiling systems, coordinate power pack locations with Architect prior to installation and provide access panels as required.

B. Low voltage occupancy sensors shall be provided when installed in accessible ceiling systems.

C. Sensor locations identified on Drawings are diagrammatic and are meant to indicate only that occupancy sensing within a given space is required. Locate sensors to provide maximum coverage of the room, to operate as someone enters the room, and to avoid false operation due to persons outside the room passing an open door.

D. Provide additional sensing heads as necessary or per manufacturer’s recommendation to achieve complete coverage of each room.

E. Set sensitivity as required to provide small movement coverage throughout the room without extending coverage beyond the room.

F. System performance testing shall be done with the sensor timing set to the minimum time delay available. Once complete coverage of a given room has been demonstrated, set the delay to 30 minutes.

G. Upon Completion of installation and prior to turning space over to Owner, Contractor shall reset occupancy sensor automatic self-adjustment settings to insure proper time delay self-adjustment for Owner occupant schedule and room use.

H. Allow for up to 24 hours of call-back sensor adjustments to be made by the contractor or occupancy sensor manufacturer qualified installer for up to six months after the owner has taken occupancy of the space.

3.5 TESTING

A. Receptacles shall be tested for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

END OF SECTION

MOTOR CONTROLLERS

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Provide manual or magnetic motor starters of the proper characteristics for equipment as indicated.
   2. Provide switches of proper characteristics as disconnecting means.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cable.
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   3. Section 26 05 53 Identification for Electrical Systems.
   4. Section 26 05 73 Overcurrent Protective Device Coordination Study
   5. Section 26 05 80 Electrical Testing

1.3 SUBMITTALS

A. Shop drawings, including the following information.
   1. Field dimensions.
   2. Description of materials and finishes
   3. Component connections
   4. Anchorage methods.
   5. Installation procedures.

B. Product data.

C. Operating and maintenance data.

D. Overload (heater) Sizing: A final listing of all motors and the heater size installed for that motor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Motor Control Centers, Motor Starters and Visible Blade Disconnects: Same manufacture as the distribution equipment specified in Section 26 24 13, Allen Bradley or approved equivalent.

B. Horsepower Rated Toggle Switches: Arrow Hart, General Electric, Hubbell, Pass & Seymour.

2.2 MOTOR STARTERS

A. Manual starters: NEMA ICS 2, AC general purpose Class A manually operated toggle type full voltage controller for fractional horsepower induction motors, quick-make, quick-break, with thermal overload protection and suitable enclosures.

B. Magnetic starters, Non-reversing: NEMA ICS 2, AC general purpose, full voltage across the line non-reversing type, 120 volt coils, overload relays in each leg, running pilot lights, one normally closed and one normally open auxiliary contacts, 120V control transformers and suitable enclosures. Overload relays shall be an ambient compensated bimetallic type with interchangeable heater pacts. Overload shall be adjustable, have single-phase sensitivity, and manual or automatic reset. Starters shall be suitable for the addition of at least four auxiliary contacts of any arrangement normally open or normally closed. Each starter shall be provided with a NO and a NC auxiliary contacts. The starter shall have a minimum fault interrupting rating of 10,000A.

C. Magnetic Starters, Reversing: NEMA ICS 2, AC general purpose. Reversing starters shall consist of two contactors and a single overload relays assembly. Include electrical interlock and integral adjustable time delay transition between FORWARD and REVERSE rotation. Starters shall be electrically and mechanically interlocked to prohibit line shorts and both starters being energized simultaneously.

D. Magnetic Starters, Two Speed: NEMA ICS 2, AC general purpose. Include electrical interlock and integral adjustable time delay transition between SLOW and FAST speeds. Starters shall be electrically and mechanically interlocked to prohibit both starters being energized simultaneously.

E. Combination Starter/Disconnect, (Circuit Breaker): Combine magnetic motor starter as described above and [motor circuit protector] [thermal magnetic circuit breaker] disconnect in a common enclosure.
   1. Motor Circuit Protector: NEMA AB 1, circuit breaker with integral instantaneous magnetic trip in each pole. Circuit protector shall have an externally operated handle, giving positive visual indication of its ON-OFF position.
   2. Thermal Magnetic Circuit Breaker: NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole. Circuit protector shall have an externally operated handle, giving positive visual indication of its ON-OFF position.

F. Combination Starter/Disconnect, Disconnect Switch Type: Combine magnetic motor starter as described above and non-fused or fused disconnect switch in a common enclosure. Switch type shall be as indicated on the drawings. Switch shall have an externally operated handle that shall give positive visual indication of its ON-OFF position.
   1. Non-fused Switch Assemblies: NEMA KS 1, enclosed knife switch with enclosed, but visible blades. Switch shall be rated as indicated on the drawings.
   2. Fused Switch Assemblies: NEMA KS 1, enclosed knife switch. Fuse clips shall accept Class R fuses. Switch and fuse sizes shall be as indicated on the drawings.

G. Starter Contacts: Totally enclosed, double break, silver-cadmium-oxide power contacts. Contact inspection or replacement shall be possible without disturbing line or load wiring.

H. Overload Relay: NEMA ICS with one-piece thermal unit construction. Thermal units shall be interchangeable. Overload relay control circuit contact shall be replaceable. Thermal units shall be required for starter to operate.

I. Enclosure: ANSI/NEMA ICS 6, Type 1 as indicated, or as required to meet the conditions of installation.

J. Equip starters with H-O-A selector switches, start-stop stations, or other auxiliary control device listed. Where no auxiliary devices are listed, equip each starter with an H-O-A switch.

K. Control circuit transformer shall be provided in each starter. Transformer shall be sized to accommodate the contactor(s) and all control circuit loads. The transformer shall include primary and secondary fuses in all ungrounded conductors.

L. Provide one normally open and one normally closed auxiliary contacts in each starter, unless additional auxiliary contacts are required. Contacts shall be NEMA ICS 2.

M. All starter units shall be provided with control terminal blocks. Terminal blocks shall be rated at 20-Amperes and shall be accessible from inside the unit with the unit door is opened.

N. Push Buttons: Unguarded, recessed type

O. Indicating Lights: LED type, color to be Green for run, Red for stopped unless otherwise indicated.

2.3 DISCONNECTS

A. Safety and disconnect switches shall be NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Switches shall be equipped with a defeatable cover interlock.

B. Enclosures shall be NEMA l for indoor use, unless specifically noted otherwise and NEMA 3R where installed exposed to the weather or designated by the subscript “WP”.

C. Disconnects shall be fusible or non-fusible as designated on Drawings.

2.4 FUSES

A. Fuses shall be UL Class RK-5 dual element, time delay, current limiting type. The overload thermal time delay element shall be a spring actuated soldered copper assembly in a separate sand free compartment. The short circuit current limiting section shall be copper alloy links encased in quartz sand.

B. Fuses shall be capable of holding 500% of rated current for a minimum of 10 seconds, and carry a UL listed minimum interrupting rating of 200,000 amperes rms symmetrical.

2.5 POWER MODULE (ELEVATOR SHUNT TRIP)

A. Motor rated, fused power switch (size as indicated on drawings) with integral shunt trip attachment, control power transformer, control power fuses and blocks, fuse covers, key to test, pilot lights and fire alarm interface relay to NEMA I enclosure for emergency shutdown of elevator power. Provide auxiliary contacts for elevator battery lowering device to sense if power module was manually or unintentionally turned-off. Bussmann #PS series, Littelfuse, Ferrazshaw-Mersen or approved.

PART 3 - EXECUTION

3.1 MOTOR STARTERS

A. Provide the motor starting equipment as shown on the Drawings and coordinate all motor “overload” starter relays.

B. Install the starters at the respective equipment unless shown otherwise.

C. Freestanding starters shall be installed on metal channel support structure.

D. Starters that are installed on exterior walls shall be installed with minimum 1/2-inch channel on wall to allow air space between starter and wall.

E. Where fusible units are provided, install fuses as indicated on the drawings.

F. Thermal overloads (heaters) shall be installed in each starter in accordance with the manufacturer’s recommendations for that motor and the type of associated load. Coordinate proper size when individual power factor capacitors are utilized at the motor.

3.2 DISCONNECT SWITCHES

A. Provide all code required disconnect switches under this work, whether specifically shown or not.

B. Non-fusible disconnect switches required when equipment is not in sight of the branch circuit panel or starter may be horsepower rated, toggle type in suitable enclosure, mounted at or on the equipment.

3.3 FUSES

A. Install fuses for motor protection to best protect the motor without nuisance tripping. Should fuse sizes require changing from what is shown due to variance between the original design information and actual equipment installed, fuses shall be sized in accordance with NEC. In no case shall fuses be sized smaller than the starter heaters on motor circuits.

B. Provide one complete set of spare fuses of each amperage used on this project. Store spare fuses in the spare fuse cabinet.

3.4 COORDINATION

A. Verify the characteristics and the motor full load current for each motor installed, using the actual motor nameplate data. Select and install the proper running overload devices in the starter as per the manufacturer's instructions. Provide the proper overload protection is a part of this Division of the work.

B. Prepare table of all motor full load currents and installed overload devices and submit to the Architect.

END OF SECTION

ENGINE GENERATORS

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Provide an Emergency Power Generation System complete as indicated.
   2. The power system shall consist of a natural gas engine driven electric generator set with control panel, cooling system, governor, starter motor, structural steel skid base and all other accessories needed for proper operation, including exhaust system, fuel system, automatic battery charger, starting batteries, battery cables, battery heater, water jacket coolant heater, remote annunciator panel, and other accessories as required for operation as specified below. The complete system is intended to automatically provide continuous electric power for the duration of any failure of the normal utility electric supply.
   3. The system shall have a minimum standby output rating as noted on the plans.
   4. The system shall be enclosed in a sound-attenuating, weatherproof enclosure and contain all accessories necessary for reliable operation in outdoor ambient conditions for the project location.
   5. The system exhaust emmissions levels shall comply with requirements of the local air pollution authority, or EPA requirements; whichever is more stringent.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   3. Section 26 05 53 Identification for Electrical Systems.
   4. Section 26 05 73 Overcurrent Protective Device Coordination Study.
   5. Section 26 05 80 Electrical Testing.

1.3 QUALITY ASSURANCE

A. The engine generator set shall be the product of a firm regularly engaged in the assembly or manufacturer of this equipment. The component parts of the unit shall be the product of firms regularly engaged in the manufacture of these parts.

B. It is the intention of these specifications to secure equipment that can be properly maintained and serviced without the necessity of carrying expensive parts, stocks or being subjected to the inconvenience of interrupted service due to the lack of available parts.

C. An engine of the same model, bore, stroke, configuration and rpm as the engine submitted, shall have a minimum of 2000 hours of satisfactory operation under average rated load conditions of 75% or greater over a 2-year period. Satisfactory operation is defined as an availability of at least 95% with no period of downtime for repair in excess of 75 hours. Certification of the above equipment experience, either from field installations or laboratory testing, shall be provided. NEMA certification that the generator meets all applicable NEMA standards shall be provided. Certifications shall be included with the shop drawing submittal.

1.4 CODES AND STANDARDS

A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.
   1. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
   2. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
   3. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

B. The generator set and supplied accessories shall meet the requirements of the following standards:
   1. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
   2. UL1236 – Battery Chargers
   3. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

C. The control system for the generator set shall comply with the following requirements.
   1. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
   2. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
   3. FCC Part 15, Subpart B.
   4. IEC8528 part 4. Control Systems for Generator Sets
   5. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
   6. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
   7. UL1236 –Battery Chargers.

D. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. Underwriters Laboratories (UL).
      a. 508 Industrial Control Equipment
      b. 1008Automatic Transfer Switches
   2. National Fire Protection Association (NFPA)
      a. 30 Flammables and Combustible Liquids
      b. 37 Stationary Combustion Engines and Gas Turbines
      c. 70 National Electrical Code (NEC)
      d. 110 Emergency and Standby Power Systems
   3. National Electrical Manufacturer's Association (NEMA)
      a. ICS Industrial Controls and Systems
      b. MG-1 Motors and Generators

1.6 SUBMITTALS

A. Shop drawings.

B. Product data.

C. Site test report.

D. Operating and Maintenance Data:
   1. Complete instructions covering the operation and testing of the engine generator and associated equipment shall be provided for the plant, together with a manual covering engine operation and maintenance. Operation instructions shall include any minor adjustments necessary to obtain optimum operation of the set.
   2. Maintenance instructions shall include complete trouble shooting and diagnostic information, disassembly instructions, assembly instructions and preventive maintenance schedule.
   3. The preventive maintenance schedule shall be in outline form. Include recommended lubricants and specified all necessary service checks. Spare parts books for the engine generator and associated equipment shall also be furnished.
   4. Include data in Operating and Maintenance Manuals specified in Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cummins, Caterpillar, Generac, Katolight, Kohler.

B. The design shown on the contract documents is based on Cummins product. Substitutions shall be subject to review and approval by the Architect and Engineer. Contractor shall be responsible for deviations in substitute equipment which imposes design changes on the contract documents, and shall provide engineering services payment to the associated Architect/Engineer of Record at their standard hourly rates.

2.2 ENGINE

A. Engine shall be a natural gas fueled, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Engine accessories and features shall include:
   1. Complete engine fuel system, including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set.

B. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

C. Skid-mounted radiator and cooling system rated for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H2O external static head. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator system and rejection heat shall be integral with the generator enclosure. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.

D. Electric starter(s) capable of three complete cranking cycles without overheating.

E. Positive displacement, mechanical, full pressure, lubrication oil pump.

F. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

G. Replaceable dry element air cleaner with restriction indicator.

H. Flexible fuel lines.

I. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.

J. Coolant heater
   1. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
   2. The coolant heater shall be installed on the engine with high temperature silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
   3. The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
   4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

K. Provide vibration isolators, spring/pad type or as recommended by the manufacturer, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

L. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.

M. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

2.3 BATTERY CHARGER

A. Provide a battery charger and battery system integral with generator sound attenuating weatherproof enclosure.

B. Provide a minimum 12 amp battery charger for each generator set battery bank. Generator sets incorporating two battery banks shall be provided with two chargers connected together and operating in parallel, with alarm output(s) connected in parallel. The charger(s) shall include the following capabilities:
   1. Chargers shall be UL 1236-BBHH listed and CSA or CUL certified for use in emergency applications.
   2. The charger shall be compliant with UL991 requirements for vibration resistance.
   3. The charger shall comply with the requirements of EN61000-4-5 for voltage surge resistance; EN50082-2 for immunity; EN61000-4-2 for ESD; EN61000-4-3 for radiated immunity; ANSI/IEEE C62.41 category B and IN61000-4-4 for electrically fast transient; EN61000-4-6 for conducted emissions; and FCC Part 15 Class A for radiated emissions.
   4. The charger shall be capable of charging a fully discharged battery without damage to the charger. It shall be capable of returning a fully discharged battery to fully charged condition within 24 hours. The charger shall be UL-labeled with the maximum battery amp-hour rating that can be recharged within 24 hours.

5. The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to maintain a fully charge battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.
6. The DC output voltage regulation shall be within plus or minus 1%. The DC output ripple current shall not exceed 1 amp at rated output current level.
7. The charger shall include the following features:
    a. two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and perform programming;
    b. LED indicating lamp(s) to indicating normal charging condition (green), equalize charge state (amber), and fault condition (red);
    c. AC input overcurrent, over voltage, and undervoltage protection;
    d. DC output overcurrent protection;
    e. Alarm output relay
    f. Corrosion resistant aluminum enclosure

2.4 AC GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Alternator temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.

B. The generator set shall be provided with a mounted main line molded case circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

C. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

D. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

E. The subtransient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

F. The alternator shall be capable of operation with reverse kVAR of 0.15 per unit.

2.5 INSTRUMENTS AND CONTROLS

A. The following engine and generator instruments and controls shall be furnished and installed in a control panel mounted on the engine generator set:
1. Lube oil pressure gauge.
2. Water temperature gauge.
3. Engine running time hour meter.
4. Manual start/stop switch.
5. Engine protective alarms.
6. AC voltmeter.

7. AC ammeter.
8. Phase selector switches for voltmeter and ammeter.
9. Frequency meter.
10. Voltage adjust control.

B. The governor manual speed adjusting control may be either mechanical or electrical. All instrumentation shall be isolated to prevent damage from engine generator set vibration.

2.6 REMOTE ANNUNCIATOR

A. Provide remote annunciators adjacent to the generator (not mounted on the generator) and in the Custodial Room**.** The annunciator shall include the following panel-mounted visual indicating lights:
1. Generator on line.
2. Battery charger malfunction.
3. Low lube oil pressure.
4. Low coolant temperature.
5. High coolant temperature.
6. Engine overcrank shutdown.
7. Engine overspeed shutdown.
8. Controls not in “automatic”.
9. Remote emergency stop.

B. Annunciator shall include an audible alarm to sound when any of the alarm conditions 2 through 9 in paragraph A above exist. Equip audible alarm with a silencing switch with ringback feature.

C. Indicating lights shall remain “ON” as long as faults are uncorrected. Equip lights with lamp test device.

D. Remote annunciator device power shall be derived from the engine starting battery/charger system.

2.7 AUTOMATIC OPERATION

A. The engine generator set shall be equipped with an automatic control system to start and stop the unit. The automatic engine starting control shall operate from auxiliary contacts in the automatic transfer switch which close for engine run and open for engine stop. The starting control circuits shall be arranged so that cranking will commence immediately after closing of the auxiliary contact. Four (4) cranking cycles of 10 seconds “on” and 10 seconds “off” shall be provided. If the engine has not started and the completion of the 4 cranking cycles, or if any safety device should operate while the engine is in operation, the unit shall be stopped immediately and the starting controls locked out, requiring manual resetting. The starting control equipment shall be capable of operating at 75% normal DC voltage. The overcrank indicating light shall indicate that the engine has not started at the completion of the 4 cranking cycles. After the engine successfully starts, the starting control shall automatically disconnect the cranking controls.

B. A selector switch shall provide (1) “manual” or “handcrank”, (2) “off” or “stop” (3) “automatic” and (4) “engine test” positions.

C. Load shedding controls shall be integral with the generator controller, capable of being programmed for varying load-shedding inputs. Provide minimum (2) independently programmable load-shedding output contacts for interface with transfer switch equipment. Generator shall come from factory with (1) load shedding output factory-programmed to send load shedding signal to Standby Transfer Switch dropping the load when generator is at 80% load capacity. This factory setting shall be field adjustable.

2.8 WEATHERPROOF HOUSING

A. Provide a weatherproof sound attenuating housing which shall completely enclose the engine-generator set. Provide housing with noise abatement insulation. Level 2 housing shall attenuate generator noise emission sound pressure levels to 73 - 77dBa at 7 meters. The housing shall contain all louvers and controls to automatically open upon engine start-up and close after shutdown. Engine silencer shall be installed inside of the enclosure.

B. The side panels shall be lockable and removable for servicing of the engine-generator. Provide 2 sets of keys to the owner at completion of the project. Housing shall have baked enamel finish in color as selected by Architect.

C. Provide two 12VDC luminaires with switch on control panel to light the engine-alternator for use in maintaining the generator set. Connect to engine starting system. Include overcurrent protection for the luminaire circuit.

D. Provide one weatherproof GFCI 20A duplex receptacle mounted to skid base for connection to 120V field wiring.

PART 3 - EXECUTION

3.1 ANCHORING

A. Generator to be anchored to concrete slab per structural requirements. Coordinate anchorage requirements on approved manufacturer shop drawings with structural requirements. Discrepancies shall be brought to the attention of the Architect and Structural Engineer prior to rough-in and concrete pad installation.

3.2 ELECTRICAL WIRING

A. All conduit, wiring, and electrical connections required between the various items of the System shall be provided and installed complete.

3.3 SUPERVISION

A. Installation and start-up shall be supervised, checked and tested by a qualified representative of the engine generator manufacturer.

3.4 FIELD TEST

A. After the installation and initial start-up of the engine generator set is complete, a test shall be performed and logged in the presence of the Architect. The Contractor shall have the engine generator manufacturer furnish an engineer to operate the engine during the tests, to check all details of the installation and to instruct the operators. This engineer will be required for a period of not less than 2 days for instruction and tests and all costs in connection therewith shall be included in the Contractor's bid. The Contractor shall furnish all fuel, lubricants, load banks and instruments necessary to conduct the tests and shall connect all devices required to obtain data required below. The resistor load bank shall be connected to load side of the automatic transfer switch and the Contractor shall make any necessary temporary connections to obtain full load for the test.

B. Field Test Requirements: Data shall be recorded every 15 minutes and at the beginning and end of every separate test and shall include all electrical and temperature information. Testing shall be accomplished in the following sequence:
   1. Check all engine and generator mounting bolts. Check alignment of engine generator and realign if not within manufacturer's limits.
   2. Test generator and exciter insulation resistance with a megger. Take generator readings at circuit breaker or at leads to switchboard. Record all results in the test report.
   3. Perform engine manufacturer's recommended prestarting checks. Include a check of water, fuel and lube oil levels within the engine.
   4. Start engine and make engine manufacturer's after starting checks during a reasonable run-in or warmup period.

5. Operate engine generator set for one hour at 50% of rated load.
6. Operate engine generator set for one hour at 75% of rated load.
7. Operate engine generator set for two hours at 100% of rated load.
8. Measure sound level to assure that the sound spectrum does not exceed the criteria specified.
9. Increase engine speed by manually overriding the governor. Speed shall be measured by a tachometer. Record speed at which overspeed trip operates.
10. Demonstrate functioning of high temperature coolant circuit by restricting air flow through the radiator.
11. Shutdown engine and observe operation of low oil pressure control. Record pressure at which trip operates. NOTE: If safety conditions of the Safety System are not met during any of the preceding three steps, the necessary readjustments shall be made and the step repeated until satisfactory results are obtained.
12. Ensure proper operation of the automatic exercising system by setting system for automatic operation then manually initiating an exercise period of at least 30 minutes.
13. A battery starting test shall be performed with the charger disconnected, consisting of four (4) cranking cycles of 10 seconds “on” and 10 seconds “off”. The engine fuel supply shall be shut off to prevent starting.
14. Document all test results and furnish to Owner upon successful completion.

C. Checks to be made during on-site testing:
   1. Proper operation of all controls.
   2. Proper operation of all gauges and instruments throughout operation.
   3. Proper operation of all auxiliary and accessory equipment. All valves, including pilot valves and injection pump, shall be checked during the tests to assure proper operation.

D. Inspection: Upon completion of the on-site tests, a general inspection shall be made for:
   1. Proper anchorage.
   2. Leaks in the engine, piping systems, tanks, etc.
   3. Excessive blow-by.
   4. Any other deficiency which may impair proper operation.

3.5 ACCEPTANCE

A. Final acceptance shall be made when the generator set has successfully completed the onsite tests and after all defects in material or operation have been corrected.

END OF SECTION

AUTOMATIC TRANSFER SWITCHES

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes: Provide Automatic Transfer Switches as indicated.

B. Related Sections include:
1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
3. Section 26 05 33 Raceways and Boxes for Electrical Systems.
4. Section 26 05 53 Identification for Electrical Systems.
5. Section 26 05 73 Overcurrent Protective Device Coordination Study.
6. Section 26 05 80 Electrical Testing.
7. Section 26 32 13 Engine Generators.

1.3 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
1. Underwriters Laboratories (UL).
   a. 508 Industrial Control Equipment
   b. 1008Automatic Transfer Switches
2. National Fire Protection Association (NFPA)
   a. 70 National Electrical Code (NEC)
   b. 110 Emergency and Standby Power Systems
3. National Electrical Manufacturer's Association (NEMA)
   a. ICS Industrial Controls and Systems

1.4 SUBMITTALS

A. Shop drawings.

B. Product data.

C. Operating and Maintenance Data:
1. Complete instructions covering the operation and testing of the automatic transfer switches.
2. Maintenance instructions shall include complete trouble shooting and diagnostic information, disassembly instructions, assembly instructions and preventive maintenance schedule.
3. Include data in Operating and Maintenance Manuals specified in Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Automatic transfer switches shall be the same manufacturer as the engine generator equipment specified in section 26 32 13

B. Cummins, Asco, GE Zenith Controls, Russelectric or approved.

2.2 AUTOMATIC TRANSFER SWITCHING SYSTEM

A. Each switch shall be furnished with full load current rating, voltage, phase, poles and AIC ratings as shown on the drawings. Transfer switches shall be capable of switching all classes of load and shall be rated for continuous duty when installed in non-ventilated enclosures.

B. Transfer switches shall be 4-pole type provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar.

C. Relays and control circuits shall be provided to obtain fixed preferential control with transfer switch connected to the normal source of power under normal conditions. Upon a sustained drop in voltage of 30% in any phase of the normal power source from rated voltage and after a delay of 2 seconds, switch shall close a circuit to automatically start the alternate power source and transfer the load to the alternate power source provided the voltage and frequency of that source are at least 90% of rated value. The switch shall be electrically operated but mechanically held in both the normal and standby positions and shall include an electrically continuous neutral position. The operator shall be momentarily energized from the source to which the load is being transferred. Upon return of normal power to within 10% of rated voltage on all phases, and after a preset time delay adjustable from 2 to 25 minutes, the switch shall automatically transfer the load to the normal source. If the standby power source should fail during the delay period prior to return to normal source, the time delay shall be bypassed and the switch shall return immediately to the normal source. A test switch shall be provided to simulate failure of the normal power source and to test the operation of a transfer switch. A manual operator shall be provided for maintenance servicing of the transfer switch in accordance with UL-1008. An override switch shall be provided to bypass the automatic transfer controls so that the transferred switch will remain indefinitely connected to the standby power source, regardless of the condition of the normal power source.

D. Each automatic transfer switch shall be furnished with voltage sensing relays for each phase. Connection of these sensing relays shall be made to the normal power input terminals of the transfer switch. Voltage range shall be field adjustable.

E. Delayed Transition: The controls shall include a time delay, adjustable from 0-60 seconds, to control the switching time from source to source, to allow load generated voltages to decay before connecting to an energized source.

F. High intensity LED lamps shall be provided to indicate Source 1 and Source 2 Available, Source 1 and Source 2 Connected, exercise mode, and test mode. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control. These signals shall be transmitted to the remote annunciator. Provide one set Form C auxiliary contacts indicating transfer switch position, rated 10 amps 250 VAC.

G. The automatic transfer switch shall be installed in a NEMA Type I wall mounted enclosure conforming to NEMA ICS and comply with the requirements of UL-508.

H. Provide a field-configurable exerciser clock, displaying real time in hours and minutes, with provisions for selection of testing interval at 7, 14, 21, or 28-day intervals in either with-load or without-load configuration. Exercise period duration shall be field configurable.

I. Transfer switch shall be provided with AL/CU mechanical lugs sized for the full output rating of the switch, and capable of accepting the number of cables indicated on the drawings.

J. The automatic transfer switch shall be suitable for satisfactory performance when installed for operation at 200-feet altitude, 40°C high and 5°C low ambient temperature, 90% relative humidity.

K. All surfaces to be painted shall be thoroughly cleaned to insure that they are free from all oil, grease, welding slag and spatter, all mill scale, products of corrosion, dirt or other foreign products. Painting shall consist of at least one coat of rust inhibiting primer and one coat of finish enamel. The rust inhibiting primer shall be applied to a clean, dry surface as soon as practicable after cleaning. Painting shall be with manufacturer's current materials according to manufacturer's current process except that the total dry film thickness shall be not less than 2.5 mils. The paint shall be free from runs, sags, orange peel or other defects. Color of the finish coat of paint shall be manufacturer's standard.

L. Load shedding controls: Standby transfer switch shall be capable of receiving load shed controls from the generator controller to connect or disconnect the transfer switch load based on contact input.

M. The automatic transfer switch shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship. The warranty shall be comprehensive, including parts, labor, and travel to the site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Transfer Switches shall be mounted square and plumb, with top of switches 6 feet – 0 inches above finish floor.

B. All conduit, wiring, and electrical connections required between the various items of the System shall be provided and installed complete.

C. Engage a factory-authorized service representative to inspect the equipment, verify installation meets the manufacturer's requirements, and perform manufacturer recommended start-up testing.

D. Engage a factory-authorized representative to provide training of the Owner's personnel to adjust, operate, and maintain the automatic transfer switch equipment.

END OF SECTION

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. This Section describes the materials and installation requirements for Surge Protective Devices (SPD). SPD's are used for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

B. This specification also describes the mechanical and the electrical requirements for the SPD. The SPD shall be suitable for application in both category B and C environments as described in ANSI/IEEE C62.41- 2002.

C. The Contractor shall furnish and install the Surge Protective Devices having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract documents. Related hardware (i.e. flush mounting kits, mounting brackets, etc.) shall be provided as required for the installation of the SPD system suitable for the application.

1.2 RELATED DOCUMENTS

A. This Section includes: Surge Protective Devices (SPD) for low voltage power equipment and shall provide effective high energy protection against transient surges, temporary over-voltages, voltage swells and high frequency noise attenuation.

B. Related Sections include:
   1. Section 26 23 13 Switchboards.
   2. Section 26 24 16 Panelboards.

1.3 REFERENCE STANDARDS

A. ANSI/UL 1449 (Underwriters Laboratories) Third Edition - Standard for Safety for Surge Protective Devices.

B. ANSI C84.1 (American National Standards Institute) - American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hertz).

C. IEEE C62.41.1 (Institute of Electrical and Electronics Engineers) - Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.

D. IEEE C62.41.2 (Institute of Electrical and Electronics Engineers) - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

E. IEEE C62.45 (Institute of Electrical and Electronics Engineers) - IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.

F. IEEE 142 (Institute of Electrical and Electronics Engineers) - IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book).

G. IEEE 1100 (Institute of Electrical and Electronics Engineers) - IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).

H. ISO 9001 (International Organization for Standardization) Quality Systems – Quality Management System

I. MIL Standard 220 (Department of Defense) - Test Method Standard, Method of Insertion-loss Measurement.

J. NFPA 70 (National Fire Protection Association) - National Electrical Code.

K. UL 1283 (Underwriters Laboratories) - Standard for Safety for Electromagnetic Interference Filters.

1.4 SUBMITTALS

A. Submittals shall include written specification response referencing each specification section and sub-section indicating compliance or non-compliance. If manufacturer cannot fully comply with specification section, this must be stated in the response along with a full description of the variance.

B. Submit the following information, indexed by response and test results. Submittal shall be received a minimum of 2 weeks in advance of the date the submittal evaluation needs to be completed for the project.
   1. Specification compliance response sheet referencing each specification section.
   2. Proof of UL1449 Third Edition compliance from Nationally Recognized Test Lab (NRTL) accepted by local authority having jurisdiction. UL1449 Third Edition Nominal Discharge Current Rating and Voltage Protection Ratings shall be provided.
   3. UL1283 filter compliance documentation.
   4. Published specifications, cut sheets & product data with appropriate IEEE C62.41 & UL1449 Third Edition performance ratings for intended installation locations.
   5. Electrical and mechanical shop drawings.
   6. Installation requirements/instructions.
   7. Operations & maintenance manuals.
   8. Performance / warranty information.

C. The Engineer reserves the right to accept or reject any or all submittals, to request additional information as deemed necessary or to request submittals for a different unit deemed more appropriate for this installation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manuals

B. Warranty Documentation

C. Notes to Record Drawings

1.6 QUALIFICATIONS

A. Manufacturer's SPD's shall have UL1449 Third Edition compliance & listing from Nationally Recognized Test Lab (NRTL) accepted by local authority having jurisdiction. Type 1 compliance required for SPD intended for installation before (or after) Main Service Disconnect or Type 2 compliance for installation after Main Service Disconnect. Provide published UL1449 Third Edition Nominal Discharge Current Rating and Voltage Protection Rating.

B. Manufacturer shall have local representation and distribution within 400 miles of the project location to provide technical, warranty claim, and installation support for the project.

C. Manufacturer/vendor must be capable of supplying SPD for project within 30 days of receipt of order for orders of 25 units and less for models submitted in response to this specification.

D. Manufacturers shall be certified to latest ISO 9001 standard and shall be registered for the design and manufacturing of SPD devices.

E. Manufacturer shall provide access to a readily available factory engineer for answering questions about this product.

F. Only firms regularly engaged in the manufacture of SPD products for category C locations (ANSI/IEEE C62.41.1-2002), and whose products have been providing satisfactory service for not less than five years, shall be considered. Upon request, provide a customer reference list, with a minimum of five contact names and current phone numbers.

G. Manufacturer qualifications shall be provided as part of the submittal.

H. The successful manufacturer/vendor shall assign a technical contact person for SPD application, installation and warranty questions. This contact shall be available to provide a response to a technical question within a maximum of two business days.

I. Single manufacturer shall be capable of providing all power system SPD's.

1.7 DELIVERY, STORAGE AND HANDLING

A. Inspect for damage and replace any damaged device.

B. Store in a clean, dry space suitable for equipment and protect against damage.

C. Clean equipment and touch up minor scratches using suitable materials.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets and bulletins for the complete assembly and each major component.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Current Technology Inc. SPE Series, Leviton, Square D or of the same manufacture as the distribution equipment specified in Section 26 24 13.

B. The listing of specific manufacturers above does not imply acceptance of their products which do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to the bid date. Provide complete submittals for review as described above.

2.2 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

A. SPD Design:
   1. SPD shall be compatible with the electrical system voltage, current, system configuration and intended applications and shall be NRTL listed for such application.
   2. Parallel design only with individual protection components:
      a. Line to Ground and Line to Line for Delta and High Resistance Grounded systems.
      b. Line to Ground, Line to Neutral and Neutral to Ground for Wye and Single Phase distribution systems.
   3. Metal-Oxide Varistors (MOV) components shall be utilized as primary energy mitigation. Selenium cell, air gaps, gas tubes are not allowed.
   4. Maximum continuous operating voltage (MCOV) of all components (based on ANSI C84.1 standard voltages), not less than 125% for 120/208 volt systems and 115% for other systems.
   5. Short Circuit Current Ratings (SCCR) shall be suitable for location SPD is to be installed.
   6. Visual indication of protection status on each phase, visible from the front of the equipment.
   7. Protection Status:
      a. Normally open and normally closed contacts for remote monitoring.
      b. Rated a minimum of .5 amps, AC or DC.
      c. Shall change state upon device failure or loss of power.
   8. As a minimum, Branch Panel, Sub-Panel and series installed (branch circuit) SPD shall include a passive circuit which allows the SPD to actively follow the voltage waveform and provide a clamping envelope to limit low level IEEE C62.41 Category A ring waves (of either polarity) at all locations on the sine wave. This circuit shall also perform in the Neutral to Ground Mode.
   9. Complete, comprehensive installation instructions shall be provided for the SPD.

10. Enclosure:
    a. NEMA rated metal enclosure appropriate for environmental conditions and exposure at point of installation.
    b. Designed to allow connection of the SPD without sharp bends in the conductors.
    c. Metal flush kits for flush mount installations (external devices) on new and retrofit applications for panels. Kits shall include supports for fastening to structural members and shall include a face plate matching SPD finish. Retrofit kits shall be capable of being installed next to the panel after drywall has been installed without the need for patching or refinishing of the wall.

B. Performance and Ratings:
    1. Minimum durability and performance requirements are described below in accordance with test procedures outlined in ANSI/IEEE C62.45 & UL1449 Third Edition. Test documentation shall be provided as part of the submittal package. Information shall be provided in a format which is easily to analyze and review. The following test data shall be submitted as manufacturer published literature:
        a. Provide Peak Surge Current (Single Pulse Rated, 8/20µS, by mode, Amperes) with submittals document for each SPD proposed. For all electrical equipment located at Service Entrance or Category C locations, Surge current rating shall be a minimum of 160kA per phase / 80kA per mode for IEEE C62.41.1-2002 - Category C Low Exposure locations and 300kA per phase / 150kA per mode for IEEE C62.41.1-2002-Category C High Exposure locations or critical locations.
        b. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G & N-G) with submittals.
        c. Surge current rating shall be a minimum of 80kA per phase / 40kA per mode in low exposure locations or 120kA per phase / 60kA per mode for distribution switchboards or motor control centers in medium and high exposure / critical equipment locations and for IEEE C62.41.1-2002 - Category B & C Switchboard and Motor Control Center Locations.
        d. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G & N-G) with submittals.
        e. Surge current rating shall be a minimum of 80kA per phase / 40kA per mode for branch panel models in low, medium and high exposure areas and for IEEE C62.41.1-2002 - Category B & C Panel and Sub-Panel Locations.
        f. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G & N-G) with submittals.
        g. For each SPD proposed, provide published durability test data utilizing the ANSI/IEEE C62.41-1991, Category C3, 20kV/10kA, 1.2 x 50 µS - 8x20 µS combination waveform for SPD durability tests with (as a minimum), the ANSI/IEEE C62.41-1991, Category C1, 6kV/3kA, 1.2 x 50 µS - 8x20 µS combination waveform used for pre and post test measurement of let through performance variation. Provide test data with submittals, including test setup information.
        h. All SPD devices (including branch panel) shall withstand a minimum of 15,000 IEEE C3 20kV/10kA hits delivered at a rate not exceeding one pulse per minute without failure or degradation exceeding 5% using IEEE B3 6kV/3kA combination waveform for pre and post durability let through measurement evaluation. Lead length for testing and let through measurements shall be 6”.
        i. UL Third Edition Nominal Discharge Current Ratings shall be a minimum of 20kA per mode for SPD’s to be installed at the Service Entrance (or where direct lightning strike potential exists on outdoor feeder or branch circuit conductors serving electrical equipment) and a minimum of 10kA per mode for all other locations.
        j. Provide EMI/RFI Attenuation as per Mil Std-220. Attenuation 40dB at 100kHz.

Maximum SPD voltage let through values are provided in Table 1 and 2 below. Provide published performance test data for the test configurations and waveforms listed in Tables with submittals. Table 1 - Peak Voltage Let Through Voltage Table for > 160 kA Units (at/ near Service Entrance locations)

*Peak Let Through Voltages (measured from zero reference) shall not exceed:

Voltage / Configuration	Test / IEEE Wave	L-N	L-G	L-L	N-G	Phase Angle
120/208 Wye	C3 – 20 kV/10ka	1050	1225	1350	1150	90
120/208 Wye	B3/C1 – 6 kV/3kA	565	590	925	550	90
120/208 Wye	A1 – 2kV/67A	260	390	360	250	90
120/208 Wye	A1 – 2kV/67A	75	115	90	100	180
120/208 Wye	UL1449 SVR	400	400	800	400	-----
120/208 Wye	UL1449 VPR	600	700	900	600	-----

*Testing shall be completed with a minimum of 6” of lead length outside of device enclosure and shall be measured from zero voltage crossing.

Note: Category A1 Ringwave applicable for locations where Active Tracking units are to be installed, including 120/208 & 120/240 Branch Panels and protection for dedicated equipment loads (where noted).

Table 2 – Peak Limiting (Let Through) Voltage Table for > 80 kA Units (Branch/Sub Panel, MCC, etc.)

*Peak Let Through Voltages (measured from zero reference) shall not exceed:

Voltage / Configuration	**Test / IEEE Wave**	**L-N**	**L-G**	**L-L**	**N-G**	**Phase Angle**
120/208 Wye	C3 – 20 kV/10ka	1050	1225	1350	1150	90
120/208 Wye	B3/C1 – 6 kV/3kA	560	585	920	540	90
120/208 Wye	A1 – 2kV/67A	260	400	370	250	90
120/208 Wye	A1 – 2kV/67A	75	100	75	75	180
120/208 Wye	UL1449 SVR	400	400	800	400	-----
120/208 Wye	UL1449 VPR	600	700	900	600	-----

*Testing shall be completed with a minimum of 6” of lead length outside of device enclosure and shall be measured from zero voltage crossing.

Note: Category A1 Ringwave applicable for locations where Active Tracking units are to be installed, including 120/208 & 120/240 Branch Panels and protection for dedicated equipment loads (where noted). Please note the phase angle is 90 degrees and measurement is positive peak voltage measured from zero reference. Measurements at 180 degrees will show significantly lower let through voltages (sine wave peak voltage is zero at 180 degrees).

2.3 WARRANTY

A. Minimum requirements:
   1. Period: 20 years from the date of substantial completion of service and activation of the system to which the SPD is attached.
   2. Full replacement of a suppressor which is damaged or fails to meet manufacturers published specifications and specifications provided within, without pro-rating value.
   3. No exclusions from failure or damage from any system anomaly (over-voltage, single phasing, lightning strike, etc. (IEEE 62.41.1). Exceptions: failure caused by wiring error, loose or missing Neutral to Ground Bond or Meggar Testing with SPD connected to power system.
   4. Factory or third party testing shall not be required.
   5. Warranty shall apply independent of facility ownership / purchaser.
   6. Replacement unit to be at facility within 7 business days of receipt of written notification of failure at no cost to the customer (exception – custom configuration or special order units).

7. Replacements: same make, model and configuration as original unit unless otherwise requested or approved.
8. Manufacturer site visit for validation of warranty claim: manufacturer/vendor must visit site within 3 days of notification at no cost. This section does not modify 1.12 (A) (6).
9. No shipping, handling, examination or other fees are allowed.

PART 3 - EXECUTION

3.1 GENERAL

A. General Application & Installation Requirements
   1. Per the manufacturer's installation instructions.
   2. Per Installation Checklist.
   3. NFPA 70 (NEC) Requirements.
   4. Per IEEE C62.41.2, 141, 142 and 1100.
   5. Local authority having jurisdiction
   6. Project engineer.

B. Units shall not tap directly to the bus without upstream over-current protection unless tap conductors are protected at their termination by NRTL listed Disconnect, Over-current and Short Circuit Protective Devices (Fuse with Disconnect and/or Circuit Breaker) properly rated for conductor and SPD Device Protection as per NRTL listing and NEC requirements.

C. Manufacturer shall provide qualified personnel to provide 1 hour of on-site installation training for contractor.

D. Clean SPD units and flush mount covers and touch up with matching paint as necessary.

E. Inspect and test SPD devices as per manufacturer specification and installation guidelines.

F. Project Engineer or their appointed representative may perform inspection of the installed suppressors. Engineer reserves the right to require corrections to the installation to comply with manufacturer installation requirements and project specifications.

3.2 TESTING

A. Complete installation checks according to the manufacturers written instructions.

B. Remove and replace malfunctioning units and retest.

3.3 SERVICE ENTRANCE

A. Service Entrance Installation Requirements
   1. One primary suppressor at each utility service entrance to the facility or as indicated on the drawings.
   2. Suppressors shall be connected to properly rated disconnect with overcurrent and short circuit protective device connected on the load side of the service entrance disconnecting means in accordance with NEC requirements.
   3. Conductors between suppressor and point of attachment shall be kept as short and straight as possible and shall be grouped together (via tie wrap) where possible. Lead length of connecting conductor shall not exceed two (2) feet without written permission of the Engineer.
   4. Suppressor's ground shall be bonded to enclosure frame and the service entrance ground bus, and conduit between the SPD and the switchboard must provide secure electrical/mechanical connections.

END OF SECTION

LIGHTING

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. General Requirements:
   1. Provide all lighting outlets indicated on the Drawings with a luminaire of the type designated and appropriate for the location.
   2. Where a luminaire type designation has been omitted and cannot be determined by the Contractor, request a clarification from the Architect in writing and provide a suitable luminaire type as directed.
   3. Coordinate installation of luminaires with the ceiling installation and all other trades to provide a total system that is neat and orderly in appearance.
   4. Luminaires located in fire rated assemblies shall be rated for use in such assemblies or shall have the assembly maintained by the installer through the use of appropriate construction techniques to maintain the assembly rating. It is the responsibility of the contractor to maintain the assembly rating and provide all required components during construction. Coordinate luminaires impacted with division 1 and life safety documents.
   5. Install all remote ballasts in enclosures as required by luminaire specified. Locate remote ballasts as shown on drawings; where no location is shown, provide recommendation for approval prior to commencing field installation. Remote mounted ballasts shall be located within the distance limitations specified by the ballast manufacturer.
   6. Coordinate voltage requirements to each luminaire as indicated on drawings.
   7. Contractor is responsible for verifying all luminaires carry a valid UL or ELT listing.
   8. All luminaires shall be procured through a distributor located within 200 miles of the project site with a valid business license in the state the project is located.
   9. Upon request of the architect, engineer or owner, provide all back-up pricing in a unit cost breakdown per luminaire. Back-up pricing shall include distributor net pricing, contractor net pricing, final owner pricing and all mark-ups and discounts (lot price or all-or-none) associated with the luminaires.
   10. Lighting related change orders shall include all back-up pricing noted above for review by the engineer and lighting designer.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
   3. Section 26 09 23 Lighting Control Devices.
   4. Section 26 09 33 Central Dimming Controls.
   5. Section 26 27 26 Wiring Devices.

1.3 QUALITY ASSURANCE

A. The lighting design for this project was based on luminaire types and manufacturers as specified.

B. Specified manufacturers are pre-qualified to bid on products where specified. Inclusion of manufacturer and product series does not relieve specified manufacturer from providing product as described in luminaire schedule; modifications to standard product, if required, shall be included with initial bid.

C. Items noted “or equivalent” do not require prior approval but shall be included with the shop drawing submittal.

D. Other “Or Approved” Manufacturers and Products: Submit Substitution Request prior to bid, complying with requirements of “Section 012 50 0 Product Options and Substitutions”. Approval shall be determined by review of the following luminaire characteristics where applicable. Lack of pertinent data on any characteristic shall constitute justification for rejection of the submittal.
   1. Performance
      a. Distribution.
      b. Utilization.
      c. Average brightness/maximum brightness.
      d. Spacing to mounting height ratio.
      e. Visual comfort probability.
   2. Construction
      a. Engineering.
      b. Workmanship.
      c. Rigidity.
      d. Permanence of materials and finishes.
   3. Installation Ease
      a. Captive parts and captive hardware.
      b. Provision for leveling.
      c. Through-wiring ease.
   4. Maintenance
      a. Relamping ease.
      b. Ease of replacement of ballast and lamp sockets.
   5. Appearance
      a. Architectural integration.
      b. Light tightness.
      c. Neat, trim styling.
      d. Conformance with design intent.

1.4 SUBMITTALS

A. Submit the following in accordance with Section 26 05 00:
   1. Shop Drawings, to include:
      a. Product Data. Provide manufacturer’s published product data information.
      b. Luminaire dimensions on a fully dimensioned line drawing.
      c. Lamp information.
      d. Lamp socket information.
      e. Ballast information using ballast manufacturers published product data information. Multiple ballasts may be submitted for single luminaire if compatible with ballast specification included in contract documents. Include certification of lamp and ballast compatibility for all submitted ballasts.
      f. Mounting details including clips, canopies, supports, and methods for attachment to structure.
      g. U.L. Labeling information.
      h. Photometric Reports consisting of:
         1) Candlepower distribution curves: Provide five plane candlepower distribution data at no more than 5 degree vertical angle increments.
         2) Coefficient of utilization table.
         3) Zonal lumen summary including overall luminaire efficiency.
         4) Luminaire luminance: Provide measured maximum brightness data for luminaires with reflectors and average brightness data for luminaires with refractors.
         5) Spacing to mounting height ratio. If parallel and perpendicular ratios differ, provide data on each plane.
         6) VCP calculations (where applicable): For general office lighting luminaires, provide typical VCP calculations for ceiling heights between 9' and 12' at 1' increments, for room sizes 20'x20' and 30'x30'.
      i. Special requirements of the specification.

2. Operation and maintenance data. Prepare two copies of a Lighting Systems Maintenance Manual consisting of the following in a hard-cover binder for review. After review, Architect will deliver one copy to Owner.
   a. One complete set of final submittals of actual product installed, including product data and shop drawings. Include product data for actual ballast installed where applicable.
   b. List of lamps used in Project, cross-referenced to fixture types, with specific manufacturer's names and ordering codes.
   c. Relamping instructions for lamps that require special precautions (tungsten halogen, metal halide, etc.).
   d. Lighting fixture cleaning instruction, including chemicals to be used or avoided.

PART 2 - PRODUCTS

2.1 GENERAL

A. Luminaires new and complete with mounting accessories, junction boxes, trims and lamps.

B. Luminaire assemblies U.L. listed.

C. Luminaires U.L. listed appropriate to mounting conditions and application.

D. Each luminaire family type (downlights, parabolics, etc.) supplied by only one manufacturer.

E. Recessed luminaires installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall carry a fire rated listing.

F. Luminaires installed under canopies, roofs or open areas and similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.

2.2 LENSES

A. Prismatic Acrylic:
   1. As specified in the Luminaire Schedule.

B. Opal acrylic:
   1. Extruded or injection molded of virgin acrylic plastic, 0.080" minimum overall thickness.
   2. As specified in the Luminaire Schedule.

C. Opal acrylic overlay: High transmittance type, extruded of virgin acrylic plastic, 0.040" overall thickness, with minimum 80% light transmittance.

2.3 REFLECTOR CONES

A. Spun of uniform gauge aluminum, free of spinning marks or other defects.

B. Shall have an integral trim flange.

C. Color and finish as specified in Luminaire Schedule.

D. All reflectors shall be of the Alzak® process, and shall be of the low iridescent type.

E. All luminaires using Alzak® reflector cones shall be supplied by the same manufacturer unless directed otherwise in Luminaire Schedule.

2.4 LAMPS

A. Lamp each luminaire with the suitable lamp cataloged for the specific luminaire type and as indicated as manufactured by General Electric, Philips, OSRAM/Sylvania, Venture, Ushio (MR only), EYE (MR only), or approved, or as specifically indicated in the Luminaire Schedule, or as specified herein.

B. Fluorescent:
   1. Linear Fluorescent:
      a. T-8: lamps shall be bi-pin type, Tri-Phosphor with Color Rendering Index (CRI) exceeding 82, Correlated Color Temperature (CCT) of 3500 Kelvin with a minimum initial lumen output of 2850 lumens when operated on a reference ballast with a ballast factor of 1.0, or as indicated in the Luminaire Schedule.
      b.
   2. All fluorescent lamps shall be of the same manufacturer and phosphor coating unless specifically identified in the Luminaire Schedule.

2.5 LAMP SOCKETS

A. Of configuration and design to accept standard lamp bases.

B. Linear Fluorescent:
   1. T-8: Polycarbonate medium bi-pin rotary lock type, with T12 inhibitor, copper or brass contacts. Straight-in type lampholders are not acceptable.

2.6 BALLASTS

A. Linear Fluorescent:
   1. Non-Dimming Electronic: Ballasts shall meet the requirements of UL 935 and shall bear the appropriate UL label. Tandem wiring between luminaires may be used to minimize the number of ballasts while accomplishing the switching requirements shown on the drawings. Advance, OSRAM/Sylvania, Universal Lighting Technologies, or approved. Ballasts shall have the following electrical characteristics:
      a. Parallel wired, Instant Start circuitry.
      b. High frequency operation, >40kHz.
      c. Withstand input power line transients as defined in ANSI C62.41. The ballasts shall tolerate a line voltage variation of ±10%.
      d. The power factor shall be 98% or higher.
      e. The lamp crest factor shall measure 1.7 or less for program rapid start ballasts and 1.85 or less for instant start ballasts.
      f. The average Ballast Factor shall be a minimum of [84%] [95%] [100%] under ANSI C82.2 conditions or as indicated in the Luminaire Schedule.
      g. Total harmonic distortion of the input current to the electronic ballast shall not exceed 10% of the input current and comply with FCC rules and regulations Part 18 concerning the generation of both EMF (electromagnetic interference) and RFI (radio frequency interference).
      h. Class “A” sound rated and UL Class “P” thermally protected. The ballast shall be provided with an internal fuse to protect the electrical power supply from internal component failure. The ballast shall also be short-circuit protected in the event of miswiring.
   2. 10% Dimming Electronic: Ballasts shall meet all the specifications for non-dimming electronic ballasts. Tandem wiring between luminaires shall not be used. Must be compatible with dimmers specified under Section 26 27 26. Ballast shall start lamp at any preset light output setting. Dimming control shall be by 0-10V control circuit with a positive line voltage On/Off. Lutron TVE, OSRAM/Sylvania Pho-Dim, Advance MarkVII approved to provide continuous, flicker free square law dimming from 100% output to 10% output.
   3. Ballasts shall be warranted against defects in materials and workmanship for three years. The warranty shall include either a $10 replacement labor allowance or complete replacement including labor by an agent of the manufacturer.
   4. Ballasts shall operate a maximum of twolamps. Three lamp ballasts shall not be provided.

B. All dimming ballasts controlled by a common controller shall be provided by the same manufacturer.

C. Ballasts used in enclosed and gasketed luminaires listed for use in wet locations shall be of Type 1 construction.

D. Ballasts shall be rated for the expected ambient temperature in which they are installed. All exterior installed ballasts shall be rated to start the lamps at 0°F.

E. Systems using tandem wired luminaires shall be labeled accordingly. Label shall be in the lamp compartment of each luminaire and identify the function of that luminaire. Label shall not be visible from room.

F. Ballast housing shall have circuit diagrams and lamp connections applied thereto.

G. Remote mounted ballasts shall be not be located beyond the distance limitations specified by the ballast manufacturer.

2.7 LED LUMINAIRES

A. Sheet metal housings: Minimum 22 gauge cold-rolled steel, with welded joints. Exposed weld marks and seams filled and ground smooth.

B. Door Frames for lensed luminaires: White painted, flat aluminum with mitered corners, rotary camlatches to hinge from either side.Finish: Baked white dry polyester powder, unless otherwise specified, with a minimum average reflectance of 85% on all exposed and light reflecting surfaces. Steel components shall be prepared for finishing with a 5-step zinc phosphating process prior to painting.

C. Luminaires used as air-handling registers for HVAC systems shall meet the requirements of NFPA 90A.

2.8 LINEAR LUMINAIRES

A. Extruded Aluminum Housing: One piece housing of AA 6063 T5 extruded aluminum with 0.14 minimum thickness smooth and free of tooling lines in one uninterrupted section of 1 foot to 24 foot with the cross sectional dimensions as indicated in the Luminaire Schedule. Section lengths shall be as shown on the drawings and shall be such that the luminaire shall be able to be transported into and out of the installation location after final construction without any building demolition being required.

B. Steel Housing: 20 gauge (0.7mm or 0.027”) minimum, free of dents, scratches, or other defects. Exposed weld marks, joints and seams shall be filled and sanded smooth before finishing. All edges shall be cleaned and dressed to remove sharp edges or burrs. Section lengths shall be as shown on the drawings comprised of 1 foot to 12 foot lengths.

C. End Plates: Die cast end plates shall be mechanically attached without exposed fasteners. End caps shall be minimum 0.125" thick.

D. Where housing sections are joined together to form a continuous row, an internal alignment spline shall be provided.

E. Finish:
   1. All exposed aluminum surfaces shall be satin etched and anodized in the color as indicated in the Luminaire Schedule.

F. Lens: Mechanically secured from within the housing. Lens shall have interior linear prisms with smooth exterior.

G. Louvers and Reflectors:
   1. White Reflectors shall be steel or aluminum, minimum 22 gauge, with hard baked white enamel finish with minimum 85% reflectance.
   2. Alzak reflectors shall be low iridescent semi-specular or as indicated in the Luminaire Schedule, Alzak® or Coilzak® with minimum reflectance of 90%.

H. Suspension:
   1. Suspension Devices, type as specified in the Luminaire Schedule:
      a. Aircraft Cable: Stainless steel type - 3/32" nominal diameter, stranded, with positive pressure, field adjustable clamp at fixture connection.
      b. Rigid Pendant: ½" nominal diameter or as specifically shown on drawings. Supplied by fixture manufacturer when available as standard product. At fixture end of stems, provide earthquake type swivel fitting to permit 45° swing in any direction away from vertical. Flat canopy to permit splice inspection after installation.
      c. Chain hangers: Length to suit fixture mounting height if shown or as field conditions dictate. Use two heavy duty chains with "S" hooks at each suspension point. Length to suit mounting height as shown on Drawings.
      d. Suspension system must permit ±13mm (1/2") minimum vertical adjustment after installation.
   2. Supports:
      a. Provide internal safety cable from fixture body to stud in outlet box.
      b. Carry fixture weight to structure and provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting. Provide diagonal seismic restraint wires per code.
   3. Feed Point:
      a. Flat-plate canopy to cover outlet box, with holes for support cable and power cord, concealed fasteners to permit splice inspection after installation.
      b. At the electrified connection provide [straight] [coiled] cord feed. Where emergency feed is required, a separate feed point shall be provided.
      c. Power cord: white multi-conductor cord, parallel to support cable (aircraft cable); within pendant (rigid pendant); or flexible conduit (chain hanger).
      d. Where emergency feed is required, a separate feed point shall be provided.
   4. Non-feed Points:
      a. 13mm (1/2") o.d. polished chrome end sleeve, inside threaded 1/4"-20, with 50mm (2") diameter. Flat white plate to cover hole in ceiling. Top of cable with ball swaged on end, to fit inside sleeve.
      b. Contractor to provide support above ceiling as required.
   5. Suspension method shall allow adjustment to be made in hanging length to allow for variance in ceiling height.
   6. All exposed paintable suspension components shall have the same finish and color as the luminaire housing.

I. Dimensions: Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified.

J. Recessed luminaires: Must be rated for use in recessed applications. If required by the owner or design team, the manufacturer must produce test data proving the product is rated for use in recessed applications.

K. CRI: luminaires shall have a minimum Color Rendering Index (CRI) of 80 or higher.

L. Color temperature shall be per the luminaire schedule. The color temperature shall not exceed a +/- tolerance of greater than 2 McAdam Elipses. Over the life of the luminaire.

M. Adjustable Lamp Mechanisms: To have aiming stops which can be permanently set to position lamp vertically and rotationally.

N. Power Supply
   1. Integral:
      a. Rated for use with the LED array specified. Warranty array and driver as an assembly. 5 year full replacement, non-pro rated warranty is required on all electronic components.

2. Remote:
    a. Rated for use with the LED array specified. Warranty array and driver as an assembly. 5 year full replacement, non-pro rated warranty is required on all electronic components.

O. Finish: All visible surfaces to be of color and texture as directed in Luminaire Schedule. All concealed interior and exterior luminaire surfaces to be matte black or as recommended by the luminaire manufacturer.

P. Testing: LED luminaires must meet the IES LM-79-08 and LM 80-08 testing requirements. The manufacturer shall provided verification of testing compliance upon request of the design team, contractor or owner.

Q. Disposal and replacement: The LED manufacturer is responsible for the disposal of expired LED arrays and heat sinks. The fixture must be clearly labeled with return information, disposal procedures and manufacturer disposal contact information. All shipping will be paid for by the owner.
1. The manufacturer is required to inform the owner of new power requirements and /or lumen output values if new replacement components prior to shipping replacement parts.
2. Disposal and replacement information will be labeled inside the luminaire and in the project operation and maintenance manuals along with all O&M requirements listed in Division 1 of the specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet the general requirements of NFPA 70, National Electric Code.

B. Mounting heights specified on drawings:
1. Wall mounted luminaires: shall be to centerline of luminaire.
2. Pendant mounted luminaires: shall be to bottom of luminaire unless specifically identified in the Luminaire Schedule or on drawings.

C. Support:
1. The luminaires shall be supported by separate means from the building structure and not from the ceiling system, ductwork, piping or other systems.
2. The final decision as to adequacy of support and alignment will be given by the Architect.

D. Level luminaires, align in straight lines, and locate as shown on the architectural elevations and reflected ceiling plan.

E. Manufacturer's labels or monograms shall not be visible after luminaire is installed, but must be included for future reference.

F. Recessed luminaires shall have trims which fit neatly and tightly to the surfaces in which they are installed without light leaks or gaps. Where necessary, install heat resistant non-rubber gaskets to prevent light leaks or moisture from entering between luminaires trim and the surface to which they are mounted.

3.2 COORDINATION OF WORK

A. The Architectural Reflected Ceiling Plans shall take preference as to the exact placement of the luminaires in the ceiling.

B. Determine ceiling types in each area and provide suitable accessories and mounting frames where required for recessed luminaires. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.

3.3 AIMING

A. Aim luminaires with proper lamps installed.

B. Aim all directional luminaires, including but not limited to luminaires described in the Contract Documents or by the luminaire manufacturer as "aimable," "adjustable," or "asymmetric" as follows:
   1. To provide the lighting pattern for which the luminaire is designed.
   2. To provide the lighting pattern as shown on the drawings.
   3. To predetermined aiming points as shown on the drawings.
   4. Where aiming cannot be determined, request, in writing, clarification from the Architect, indicating luminaires needing clarification.

C. Re-aim luminaires as determined by Architect during final project walkthrough.

D. Adjustable luminaires shall be installed with “dead” zone of rotation away from intended aiming point.

3.4 PROJECT CLOSEOUT

A. Leave luminaires clean at the time of acceptance of the work. If luminaires are deemed dirty by the Architect at completion of the work, the Contractor shall clean them at no additional cost. Protective plastic wrap is to be removed from parabolic luminaires just prior to owner acceptance.

END OF SECTION

COMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Division 27 – Communications governs the infrastructure for the low-voltage information transport systems, which include voice and data and their pathways.

B. Description of Work:

1. Furnish and install materials for the communications infrastructure systems as specified herein and as shown on the drawings. Upon completion, the systems shall be functioning in compliance with performance requirements specified.

2. The cabling specified and shown on the drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the Architect and the Owner, and at no additional cost to the Owner.

3. This division also includes telecommunications cabling, connections, and equipment needed for the A/V projection, A/V classroom systems, Distributed Antenna System, sound reinforcement, intercom and IP Video Camera cabling. Refer to “T” series drawings for locations, quantities and additional requirements.

1.02 SECTION INCLUDES

A. Definitions

B. Quality Assurance

C. Submittal Requirements

1.03 RELATED DOCUMENTS

A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

B. The following codes, associations, acts and agencies, as required by law:

1. Federal Communications Commission (FCC)
2. National Electric Code® (*NEC*®)
3. National Electrical Safety Code (NESC)
4. National Fire Protection Association (NFPA)
5. Occupational Safety and Health Administration (OSHA)

C. The following standards:

1. American National Standards Institute (ANSI)
2. National Electrical manufacturers Association (NEMA)
3. Telecommunications Industries Association (TIA)
4. Electronic Industries Association (EIA)
5. Institute of Electrical and Electronics Engineers (IEEE)
6. Underwriters Laboratories (UL®)
7. American Standards Association (ASA)

D. The following guidelines:

1. BICSI, Telecommunications Distribution Methods Manual (TDMM)

1.04 RELATED SECTIONS

A. Section 01 7900 – Demonstration and Training
B. Section 01 9113 – General Commissioning Requirements
C. Section 27 0500 – Common Work Results for Communications
D. Section 27 0513 – Communications Services
E. Section 27 0526 – Grounding and Bonding for Communications Systems
F. Section 27 0528 – Pathways for Communications Systems
E. Section 27 0528.29 - Hangers and Supports for Communications Systems
F. Section 27 0528.33 - Conduits and Backboxes for Communications Systems
G. Section 27 0528.36 - Cable Trays for Communications Systems
H. Section 27 0528.39 - Surface Raceways for Communications Systems
I. Section 27 0553 – Identification for Communication Systems
J. Section 27 0800 – Commissioning of Communications
K. Section 27 1100 – Communications Equipment Room Fittings
L. Section 27 1116 – Communications Cabinets, Racks, Frames and Enclosures
M. Section 27 1119 – Communications Terminal Blocks and Patch Panels
N. Section 27 1123 – Communications Cable Management and Ladder Rack
O. Section 27 1126 – Communications Rack Mounted Power Protection and Power Strips
P. Section 27 1313 – Communications Copper Backbone Cabling
Q. Section 27 1323 – Communications Optical Fiber Backbone Cabling
R. Section 27 1513 – Communications Copper Horizontal Cabling
S. Section 27 1543 – Communications Faceplates and Connectors
T. Section 27 1619 – Communications Patch and Station Cords
U. Section 27 2133 – Wireless Access Points
V. Section 27 4100 - Audio-Video Systems
W. Section 27 4116 – Integrated AV Systems
X. Section 27 5113 – Paging Systems
Y. Section 27 5313 – Clock Systems
Z. Section 27 5319 – Distributed Antenna Systems

1.05 DEFINITIONS

A. Advanced System Warranty – an extended warranty held either by the connectivity or cabling manufacturer directly with the Owner for this project that guarantees product and performance of the entire cabling system for the warranty period.

B. Conveniently Accessible - being capable of being reached from floor or use of 8’ step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

C. Entrance Room – A space in which the joining of campus and building telecommunications backbone facilities takes place.

D. Equipment Room – An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate crossconnect, as well as video surveillance and security equipment.

E. IDF – Intermediate Distribution Frame, also known as a Telecommunications Room (TR) or Communications Room.

F. Lead Telecommunications Installer –the project manager for the Telecommunications Subcontractor for all telecommunications work in the construction documents (T-series drawings and specification Section 27), who shall be on-site at all times while Division 27 work is being performed. This individual shall attend all construction project meetings.

G. Listed Communications Cable – A cable listed by the Underwriters Laboratory (UL®) and accepted by the local authority having jurisdiction as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to *NEC*® Section 800 for listing types and additional requirements.

H. MDF – Main Distribution Frame, also known as the Main Equipment Room.

I. Plenum – A compartment or chamber to which one or more air ducts is connected and that forms part of the air distribution system. Assume space above suspended/accessible ceilings is a plenum.

J. Plenum-rated – listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.

K. Point of Entrance (Building Entrance) - The point within a building at which the Outside Plant (OSP) communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the *NEC*®.

L. Subcontractor, Telecommunications – company responsible for all telecommunications work in the construction documents (T-series drawings and specification sections 27 0000 through 27 5313).

M. Telecommunications – in general, telecommunications refers to infrastructure/equipment needed for the voice, data, and video communications and transport systems.

N. Telecommunications Consultant – As defined for sections referring to telecommunications work only, this Consultant shall be the telecommunications design consultant employed by the Owner for the purpose of observing the work of the Communications Subcontractor(s).

O. Telecommunications Room - An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or crossconnect cabling. The Main Equipment Room may also be known as the MDF, and may be co-located with the building's Entrance Room and Equipment Room. Telecommunications Rooms will also house equipment for additional systems, such as security, cable television, and audio/video.

P. UL® – Underwriters Laboratory

1.06 QUALITY ASSURANCE

A. Project Submittal Compliance – The Project Architect shall be responsible for receiving and compiling all submittal information. As such, all such data pertaining to Section 27 shall conform to the following Division 1 Sections:

1. Section 01 6000 – Substitutions
2. Section 01 3300 – Submittals
3. Section 01 7823 – Operations and Maintenance Data
4. Section 01 7839 – Project Record Drawings

B. Telecommunications Subcontractor Qualifications

1. Company Requirements

a) The Telecommunications Subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications.

b) Telecommunications Systems specified shall be assembled and installed under the direction of a qualified Telecommunications Subcontractor. Qualification requirements shall include submittal by the Telecommunications Subcontractor to the Architect of the following:

1) List of previous projects of this scope and nature, including names and sizes of projects (to include square footage and construction cost – overall and that of the Telecommunications Subcontractor), description of work, times of completion, and names of contact persons for reference.

2) Installers shall certify that they are manufacturer-authorized or trained for work to be performed.

2. Lead Telecommunications Installer Requirements:

a) Lead Communications Installer shall be a current member of BICSI in good standing and have completed (at a minimum) BICSI ITS Installer 2 Training (for both copper and fiber).

b) Submit certificate of ITS Installer 2 Training (or higher) with bid and preconstruction submittal package.

c) Advanced training from connectivity manufacturer may be submitted in lieu of BICSI ITS Installer 2 Training. Submit manufacturer training certificates for review by Owner as substitution request as part of Pre-Bid questions. This training must be by the same manufacturer that will hold the Advanced System Warranty.

3. General Telecommunications Installer Requirements:

a) For all work associated with Specification Sections 27 all installers are to have a minimum of BICSI ITS Installer 1 Training or equivalent training from the connectivity manufacturer.

b) Submit a list with bid of names of all installers and appropriate copies of certificates verifying training with pre-construction submittal package.

C. Warranty Requirements

1. Project Warranty

a) Equipment and materials required for installation under these specifications shall be the current model and new (less than one year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect.

b) When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.

2. Advanced System Warranty for Telecommunications (Copper and Fiber Systems)

a) Beyond the initial one year project warranty, the Telecommunications Systems shall be warranted for a minimum of 20 years by a national and reputable connectivity or cabling manufacturer.

1) This warranty shall cover any material defect, as well as the performance of the cabling system. (Example: A Category 6A cabling system is to deliver 10,000BASE-T speed, or 10 “Gig” performance for the entire length of the warranty period.)

2) This warranty shall cover both material and labor for the full length of the warranty period.

b) The Telecommunications Subcontract shall be certified by this manufacturer.

c) The following manufacturers are conditionally approved to provide the system warranties (subject to specific project requirements):

1) Copper Connectivity Manufacturers

i. CommScope

ii. Panduit

2) Fiber Connectivity Manufacturers

i. CommScope

ii. Panduit

3) Cabling Manufacturers

I. CommScope

II. General (for Panduit product Set)

D. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specifications or are indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

E. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Telecommunications Consultant.

F. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility; they do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.

G. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.07 SUBMITTALS

A. General Requirements

1. Provide Submittals in accordance with Section 01 3300
2. Architect shall receive and Telecommunications Consultant is to review all submittals related to Division 27 work. This includes, but is not limited to, relevant:

a) Pre-bid questions,

b) Contractor and personnel qualifications with bid,

c) Voluntary alternates and unit pricings with bid,

d) Pre-construction product submittals and shop drawings,

e) Change order requests, requests for information (RFIs), design change directives (DCDs), and any other changes as directed by the architect/engineer.

3. Record drawings and warranty certificates/letters shall be in accordance with Section 01 7839.

4. Allow a minimum of one week (five working days) for the Telecommunications Consultant to review.

B. The following submittals are due at the Pre-Bid deadline for questions:

1. Requests for product substitution shall be in accordance with Section 01 6000
   a) All products seeking approval either as “approved equivalent” or otherwise, shall be submitted as a product substitution request prior to bid. Failure to submit product substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to the Owner.
   b) The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in substitution request:
      1) Product being replaced
      2) Reason for product substitution
      3) Full manufacturer specification sheet clearly indicating that all requirements in project documents have been met
   c) Failure to meet these requirements will result in the product substitution request being returned without review.
   d) All product substitution requests are to be reviewed and approved by the Telecommunications Consultant. Not all requests will be approved, and all decisions are final, without recourse.

C. The following submittals are due with the Bid:

1. Proof of Telecommunications Subcontractor and personnel qualifications
   a) Provide a typed list with the following information:
      1) Company name of Telecommunications Subcontractor
      2) List of connectivity or cabling manufacturers that the Telecommunications Subcontractor is certified to install and provide advanced warranty for.
      3) List of previous projects (minimum of 3) of this scope and nature, including:
         I. Project name and date of completion
         II. Project size (square feet of building, total construction cost, total cost of telecommunications scope)
         III. Name and contact information for building owner or IT Manager
      4) Name and contact information for Lead Telecommunications Installer
   b) Provide certificates or letter(s) from BICSI and / or manufacturers verifying by name these qualifications have been met.
   c) Refer to Quality Assurance subsection in this specification section for additional requirements and qualifications.
2. Voluntary alternatives (that realize substantial cost savings)
3. Unit pricing for the following items:
   a) All unit pricing relating to Division 27 as identified in Section 01 2200.

D. The following submittals are due at the Pre-Construction Phase (to be delivered to the Project Architect with copies to Telecommunications Consultant):

1. General Requirements:

a) Follow submission guidelines as outlined in Division 1. At a minimum, provide the requirements as outlined in this section. Where Division 1 requirements are more stringent, follow those in addition to the requirements in this section.

1) Strictly electronic submission to Telecommunications Consultant is acceptable. General contractor, architect, and engineering requirements may differ.

b) Ensure a cover page with Project Title, Telecommunication Subcontractor Company, and point of contact is included for all physical submittals.

c) Updated Personnel Qualifications

1) Provide a list of names of all telecommunications installers with appropriate certificates from BICSI or the manufacturer.

2. Product Information, divided by Specification Section and in order as listed in specification. Identify the start of each specification section.

a) Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.

1) Submitted cutsheets without specific product identified will result in the whole submittal being returned without review.

2) No product substitutions will be considered post bid without a significant cost savings to the project to be realized by the owner – a minimum of $1000, either in material or labor savings. For any product substitution requests post-bid, Telecommunications Subcontractor shall submit an RFI through the proper channels with the requested documentation from the Pre-bid requirements above. Also, include realized cost savings. The project team may issue a change order (or its equivalent) for the product change at their discretion.

I. One exception to this is if the specified product goes out of production and is unavailable before submitted shop drawings are approved. Telecommunications or Subcontractor is to submit an RFI explaining the situation and recommending an equivalent product with the same features at no cost change to the project or Owner.

II. Other exceptions may be considered. Telecommunications Subcontractor is to submit an RFI explaining the situation.

3. Shop Drawings

a) Conform to all requirements of Section 01 3300. In n addition, generate electronic shop drawings in AutoCAD®, dwg file format, version 2004 (or newer), saved to disk (CD-R or DVD+/-R) or USB Flash Drive with project name and number clearly indicated [or uploaded to project website]. Shop drawings shall include Telecommunications or Subcontractor title block and included readily printable Plot/Drawing tabs with mview-window at a scale to not be less than 1/8"=1'-0" unless otherwise noted. The scale shall also be indicated on the drawings.

1) Acceptable electronic shop drawing sizes include: 8.5”x11”, 11”x17”, 22”x34” or 24”x36”.

b) Stamped seismic calculations for Rack and Cabinet systems to be created by contractor for review by the AHJ.

c) Refer to individual sections for additional requirements.

d) Communications pathways

1) Hangers and Supports – indicate proposed routing of all cabling supported by J-hooks.

2) Cable Trays - indicate size and proposed routing of all communications cable trays; should any of those locations or sizes differ from the construction drawings due to minor coordination issues, cloud the affected area and note why the change is necessary. (For major coordination issues, please submit an RFI.)

3) Firestopping – indicate manufacturer, product/assembly, and UL system for all firestop penetrations required for communications cabling.

E. The following submittals are due during Construction (project closeout), in accordance with the requirements in Sections 01 7839 and 27 0000 - Communications:

1. 3 weeks prior to Substantial Completion:

a) Record Drawings

1) Modify reviewed and accepted AutoCAD® shop drawings to include revisions based upon completion of work.

2) Provide (1) printed set of record drawings to scale (not less than 1/8” = 1’-0”).

3) This set is to include system function diagrams and details not on original construction documents.

b) Test Results, in accordance with section 27 0800.

c) With the exception of the (1) printed set of record drawings, submit these files electronically either on disk (CD or DVD) or USB Flash Drive, with project name and number clearly indicated.

2. Within two weeks after Substantial Completion:

a) Warranty Certificates for the Advanced Telecommunications System Warranty for the copper and fiber systems with point of contact for any warranty claims.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.

C. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate with all other trades prior to installation.

1. Telecommunications Subcontractor shall meet with Electrical, Mechanical, and General Contractors prior to construction to identify pathway and infrastructure space requirements.
    a) At a minimum, the following items shall be discussed:
        1) Cable tray locations and clearance space above (12” if possible, with proper coordination)
        2) Placement for sleeving and wall penetrations
        3) In-ceiling projection screens and other audio/video equipment.
    b) Failure to coordinate sufficient space for telecommunications infrastructure shall result in relocation of various systems by the contractor at no additional cost to owner.
2. Prior to the start of work, the Telecommunications Subcontractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.
3. Coordinate location of equipment and conduit with other trades to minimize interference.
    a) Holes through concrete and masonry structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the General Contractor as required by limited working space.
    b) Holes shall be located so as not to affect structural sections such as ribs or beams.
    c) Holes shall be laid out in advance. The General Contractor shall be advised prior to drilling through structural sections, for determination of proper layout.
    d) Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.

B. Follow all manufacturers’ instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.

1. In the event of discrepancy, immediately notify the Telecommunications Consultant through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

C. Protection of Systems and Equipment

1. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
2. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

3. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
4. As determined by the Telecommunications Consultant, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Telecommunications Consultant shall be final.
5. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
6. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

D. Access to Equipment

1. Equipment shall be installed as per the scaled detail on the T-series Drawings. .
2. Working spaces shall be not less than specified in the National Electrical Code® for voltages specified.
3. Where the Telecommunications Consultant determines that the Telecommunications Subcontractor has installed equipment not “conveniently accessible” for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Telecommunications Consultant, at no additional cost to the Owner.

E. Cleaning

1. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying elements prior to being energized.

F. Completion

1. General:
   a) Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
2. Results Expected:
   a) Systems shall be complete and operational.

   Cleaning work shall be complete.
3. Testing and Verification – General Requirements
   a) Refer to individual sections for additional testing and verification requirements.
   b) The Telecommunications Subcontractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
   c) Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications.

d) Verification by Test and Demonstration: The Telecommunications Subcontractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Communications Subcontractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test".

e) Perform system operation tests after full enclosure of walls.

f) System Operation Tests Conducted Upon Completion of Work: Upon completion of the Telecommunications Subcontractor's Work, subject the system to functional and operational tests. When required corrections determined by initial test results have been completed, fully retest the system. The Owner shall be notified in writing not less than seven days in advance of date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable and that the Telecommunications Subcontractor has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection shall be accomplished in the presence of the Owner and the Telecommunications Consultant. At least 10 days prior to scheduled system completion, the Telecommunications Subcontractor shall submit, for approval by Owner and Telecommunications Consultant, a test plan to completely test the telecommunications system. The Telecommunications Subcontractor shall include in test plan, for acceptance by the Owner and Telecommunications Consultant, a complete and detailed final acceptance test check-off list ("punch list"). The list shall be a complete representation of specified functions and conditions.

4. Commissioning

a) There shall be three phases of commissioning:

1) Rough-in inspection

2) Above-ceiling inspection (after cables are placed)

3) Final inspection

b) At a minimum, the Telecommunications Consultant shall check the following items:

1) Accurate location and height above finished floor for all outlet boxes.

2) Accurate dimensions (particularly depth) of all outlet boxes and diameter of in-wall conduit serving outlet boxes.

3) Cable tray size, location, and clearance.

4) Location and size of all other communications conduits or pathways

5) That power receptacles within the communications rooms meet the design requirements.

6) The Telecommunications Consultant is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed.

   This report is not necessarily all inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.

c) Once all communication cabling has been installed and properly supported and walls have been painted, but prior to the installation of ceiling tiles/material, the Telecommunications Consultant shall schedule a time to be on-site to conduct above-ceiling inspection.

1) At a minimum, the Telecommunications Consultant shall check the following items:

   i. That all items from the previous inspection have been corrected.

   ii. That communications cabling is routed correctly and adequately supported.

   iii. That communications cabling is not painted or over sprayed.

   iv. That the installed communications cabling matches what was specified / submitted.

   v. That there are no kinks, splices, or other damage to the installed communications cabling.

2) The Telecommunications Consultant is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed. This report is not necessarily all inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.

d) Once all communications work has been completed, contractor shall request final inspection. This request shall be made 3 weeks before substantial completion. The Telecommunications Consultant shall then schedule a time to be on-site to conduct this inspection; the Telecommunications Consultant shall also invite the Owner to attend this inspection.

1) At a minimum, the Telecommunications Consultant shall check the following items:

   I. That all items from the previous inspections have been corrected

   II. That all faceplates are installed, with the correct modules, quantity of modules, and approved labeling scheme

   III. That all equipment and cabling within communications rooms is installed per the contract documents, including all patch panels and wall blocks (with specified spare capacity), horizontal and backbone cabling labeling, and telecommunications grounding.

IV. And all other items necessary to guarantee contract documents are met and complete and functioning communications systems are installed.

2) The Telecommunications Consultant is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed prior to substantial completion. This report is not necessarily all-inclusive; should issues be discovered within one year after substantial completion, the appropriate communications subcontractor is still responsible for corrections/repairs.

3)

END OF SECTION

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

1.02 SECTION INCLUDES

A. Summary
B. General Requirements
C. Environmental Considerations
D. Site Specific Requirements

1.03 PROJECT SUBMITTAL COMPLIANCE

A. Project Architect shall be responsible for receiving and compiling all submittal information. As such, all such data pertaining to Section 27 shall conform to the following Division 1 Sections:
   1. Section 01 6000 – Substitutions
   2. Section 01 3300 – Submittals
   3. Section 01 7823 – Operations and Maintenance Data
   4. Section 01 7839 – Project Record Drawings

1.04 RELATED SECTIONS

A. Section 27 0000 – Communications
B. Section 27 0513 – Communications Services
C. Section 27 0526 – Grounding and Bonding for Communications Systems
D. Section 27 0528 – Pathways for Communications Systems
E. Section 27 0528.29 - Hangers and Supports for Communications Systems
F. Section 27 0528.33 - Conduits and Backboxes for Communications Systems
G. Section 27 0528.36 - Cable Trays for Communications Systems
H. Section 27 0528.39 - Surface Raceways for Communications Systems
I. Section 27 0553 – Identification for Communication Systems
J. Section 27 0800 – Commissioning of Communications
K. Section 27 1100 – Communications Equipment Room Fittings
L. Section 27 1116 – Communications Cabinets, Racks, Frames and Enclosures
M. Section 27 1119 – Communications Terminal Blocks and Patch Panels
N. Section 27 1123 – Communications Cable Management and Ladder Rack
O. Section 27 1126 – Communications Rack Mounted Power Protection and Power Strips
P. Section 27 1313 – Communications Copper Backbone Cabling
Q. Section 27 1323 – Communications Optical Fiber Backbone Cabling
R. Section 27 1513 – Communications Copper Horizontal Cabling
S. Section 27 1543 – Communications Faceplates and Connectors
T. Section 27 1619 – Communications Patch and Station Cords
U. Section 27 2133 – Wireless Access Points
V. Section 27 4100 - Audio-Video Systems
W. Section 27 4116 – Integrated AV Systems
X. Section 27 5113 – Paging Systems
Y. Section 27 5313 – Clock Systems
Z. Section 27 5319 – Distributed Antenna Systems

1.05 GENERAL REQUIREMENTS

A. Eugene School District is a “tobacco free” environment. Tobacco in any form whatsoever is not permitted in this school or on the property owned by the District.

B. Eugene School District is providing new telecommunications cable and infrastructure to support District-wide deployment of wireless communications and the installation of an IP based video surveillance system. This contract will be responsible for all aspects of telecommunications cabling and supporting infrastructure required for functional systems, specifically:

1. Pathways as per Section 27 0528 and as called out on Drawings.
2. Installation of fiber backbone between the main Equipment Room (MDF) and Telecommunication Rooms (TR) or Telecommunications Cabinets as identified on Drawings. Fiber shall be 50/125μm Laser Optimized (OM3) as per Section 27 1323.
3. Installation of horizontal cabling system and related components as per Sections 27 1513 and 27 1543.
4. Installation of Wireless Access Points as identified on the Drawings and as per Sections 27 1543.
5. Testing of fiber and copper cabling systems in accordance with ANSI/TIA-568 and as outlined in Section 27 0800.
6. Creation of as-built documentation, both electronically and printed, as specified in these documents.

C. All work outlined in these documents and on the accompanying Drawings must be prior to the substantial completion date called out in Division 00 of this bid package, specifically:

1. All construction in telecommunications spaces, i.e., MDF/IDF and mounting of telecommunications racks and cabinets.
2. All raceway (including requisite surface mounted raceway), conduits, and junction boxes required for telecommunications pathways.
3. Installation and testing of all telecommunications cabling (fiber and copper) to allow District to install active electronics and bring complete systems live.
4. Test results and as-build documentation as per Section 27 0513.

1.06 SUMMARY

A. The intent of the Division 27 Specifications and the accompanying Drawings is to provide a complete and workable system as shown, specified and required by applicable codes and the Authority Having Jurisdiction (AHJ). Include all work as specified in Division 27 and shown on the accompanying Drawings, including appurtenances, to provide a complete and functional system.

B. The Division 27 Specifications and accompanying Drawings are complementary and what is called for in one shall be as binding as if called for in both. Items shown on the Drawings are not necessarily included in or called out in the Specifications and vice versa. Specifications shall supersede Drawings in the case of a conflict.

C. Imperative language is frequently used in the Division 27 Specifications. Except as otherwise noted, such requirements are to be performed by the Contractor or a Sub-contractor directly responsible to the Prime Contractor performing the Division 27 work.

D. The Drawings accompanying Division 27 (T series) are diagrammatic. They do not show every component of a complete telecommunications premises distribution system which may be required to accommodate unique building construction features or materials installed by other trades. The Drawings are to be followed as closely as practical while making necessary adjustments in the placement of cable to facilitate the overall construction of the building without additional cost to the Owner. The right is reserved to make any reasonable changes in Telecommunications Outlet locations prior to roughing-in.

1.07 ENVIRONMENTAL CONSIDERATION

A. When at all possible, equipment and materials are to be assembled at Distributors or Contractors location and delivered to construction site without packaging or shipping material. Exceptions are granted for protection of delicate components in transit.

B. Except as noted for purposes of recycling, all construction related debris; packaging and waste materials will be removed from the job site each day and disposed of by the Contractor.

1.08 SITE SPECIFIC REQUIREMENTS

A. Site details are shown on the accompanying drawings.

1.09 DEVICE LOCATIONS

A. Telecommunications Room locations as per the accompanying Drawings.

B. Telecommunications Outlets will be as per Drawings. Additions or changes will be directed by the Owner and managed via Change Order.

1.10 TELECOMMUNICATIONS CONSULTANT

A. The Telecommunications Consultant for Division 27 of this project is:
Northwest Information Services
Attn: Darren Herrick
8282 SW Nimbus, Ste #125
Beaverton, Oregon 97008
503.246.8585, extension 230
ddh@nispdx.com

or
Attn: Diane Forbes
8282 SW Nimbus, Ste #125
Beaverton, Oregon 97008
503.246.8585, extension 235
drf@nispdx.com

PART 2 (NOT USED)

PART 3 (NOT USED)

END OF SECTION

N. Applicable fire codes will be strictly adhered to in regards to plenum ratings for cable and associated cable ties. Fire stopping will be the responsibility of this contract in areas penetrated as a part of this project.

O. Installation shall be neat, well organized, and professional.

P. Installation shall be conducted as to maintain consistency between color-coding, labeling and documentation.

Q. Splicing of any unshielded twisted pair or fiber optic is not acceptable, unless directed to by specifications, addendum, drawings or other written communication with owner or authorized representative.

R. Any discrepancies, conflicts or issues must be brought to the attention of the Owner before installation or as soon as possible thereafter.

S. The Contractor shall clean up the work area at the end of each day. At the end of the project all material removed or left over, and/or not being used shall be removed from the project site unless other arrangements have been made. A final clean up shall be made before final payment is made.

T. The Contractor shall coordinate with the General Contractor for final cleaning of the Equipment and all Telecommunications Rooms. Final cleaning shall include necessary steps to remove all debris from the rooms and provide completely dust-free surfaces on all installed components.

U. All wall and floor penetrations shall be fire stopped at or before substantial completion.

3.02 PREPARATION

A. Before installation of cabling and/or equipment in telecommunications spaces, the Contractor shall field-investigate the facility and ascertain if the physical and electrical conditions within the facility shall permit commencement of the Contractor's work.

B. Any discrepancies, questions, or concerns noted at that time should be brought to the immediate attention of the Owner.

3.03 DOCUMENTATION

A. TEST REPORTS

1. The Contractor shall compile test results into the forms that contain all applicable test data. Hard copy output indicating successful testing of every location is not required.

2. A solid state USB memory device containing all test data and the appropriate application to display such in a Windows-based environment shall be provided.

3.04 AS BUILTS

A. Contractor will be provided the T series AutoCAD® drawings electronically. These drawings shall be the base drawings for the as built documentation with the following being provided by the Contractor as a separate AutoCAD® layer:

1. Outlet location,

2. Cable ID.

3.05 TELECOMMUNICATION OUTLETS

A. All locations shall be annotated with information that duplicates the labeling on the jack. In the case of a field terminated plug, such as WAPs or IP based, single cable applications the location shall be so noted.

END OF SECTION

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 SUMMARY

A. This section includes the grounding and bonding requirements for the metallic components located in the Telecommunications Rooms.

1.02 SCOPE

A. Provide all labor, materials, tools, and equipment required for the complete installation of a telecommunications grounding system.

1.03 QUALITY ASSURANCE

A. See Section 27 0513

B. All grounding and bonding cables shall be installed in a neat and workmanlike manner.

C. Grounding shall meet applicable ANSI/TIA-607-B, NEC Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice. All racks and cable trays shall be bonded to a ground bar with #6 AWG cable. All termination equipment shall be grounded according to the specifications of the manufacturer.

D. Impedance shall not exceed 5 Ω between any two metallic points within a Telecommunications Room.

PART 2 - PRODUCTS

2.01 TELECOMMUNICATIONS MAIN GROUND BUS BAR – MAIN EQUIPMENT ROOM

A. A 4” x 12” x ¼” Copper bar is to be provided by Division 26. Coordinate locations with Division 26 Contractor. Approved is Chatsworth part number 40153-012

2.02 GROUND BUS BAR – TELECOMMUNICATIONS ROOM

A. A 2” x 10” x ¼” Copper bar is to be provided by Division 26. Coordinate locations with Division 26 Contractor. Approved is Chatsworth part number 13622-012

2.03 CABLE RUNWAY GROUNDING STRAPS

A. Continuous #6 AWG with two hole compression lugs, Chatsworth part number 40164-001 or approved alternate.

B. #6 AWG from bench stock is acceptable with machine compression or exothermically applied lugs.

PART 3 - EXECUTION

3.01 GENERAL

A. A copper grounding and bonding system shall be installed which places a properly sized (as per Table 250-122 of National Electrical Code) copper cable in the immediate vicinity of the telecommunications backboard. Contractor shall be responsible for placement of the above referenced ground bus bars and terminal as well as their connection to the building system grounding cable using an exothermic-welded type connector or appropriate compression applied connector to satisfy the Authority Having Jurisdiction.

3.02 PREPARATION

A. Preparation of surfaces: Clean contacting surfaces of ground connections to bright metal before connecting

B. When making bolted connection to aluminum or galvanized structures, apply a corrosion-inhibitor such as Penetrox A to contact surfaces between connector, and surface of structure.

3.03 INSTALLATION

A. Grounding shall meet applicable ANSI/TIA-607-B, NEC® Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice. All racks and cable trays shall be bonded to a ground busbar with #6 AWG cable. All termination equipment shall be grounded according to the specifications of the manufacturer.

B. All metallic components that make up the equipment racks and ladder rack shall be bonded together in a manner that provides continuous continuity between the components. Attention must be given to the removal of paint of powder coating to present bare metal where bonding straps are fastened to the metallic component.

END OF SECTION

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 DESCRIPTION OF WORK

A. This contract shall be responsible for all hangers and support mechanisms required to properly support all telecommunications cables to satisfy the local Authority Having Jurisdiction.

B. This contract shall be responsible for all pathways as called out on Drawings, specifically:

1. Various conduits and “J-Boxes” as detailed on “T” series Drawings to accommodate Telecommunications Outlets (TO) and Wireless Access Points (WAP) locations. Any necessary penetrations shall accommodate a minimum of a Trade Size 1 EMT conduit.
2. Surface mounted raceway, as per “T” series Drawings

C. The Contractor shall coordinate with the General Contractor and all other trades in regard to final placement of telecommunications pathways. Placement shall be such that pathway will be accessible for future additions requiring placement of telecommunications cable.

D. The Contractor shall provide all labor, equipment and supplies to furnish and install the communications pathway, hangers and supports.

E. Installation shall include the actual physical installation of the hardware and/or support structure, firestopping, testing and documentation.

1.03 RELATED SECTIONS

A. Section 26 0533 - Raceways and Boxes for Electrical Systems

B. Section 27 0528.29 - Hangers and Supports for Communications Systems

C. Section 27 0528.33 - Conduits and Backboxes for Communications Systems

D. Section 27 0528.36 - Cable Trays for Communications Systems

E. Section 27 0528.39 - Surface Raceways for Communications Systems

1.04 SUBMITTALS

A. The following information shall be provided:

1. Manufacturer's literature and catalog cuts indicating:
2. Physical dimensions, including dimensions (if appropriate)
3. Materials of construction

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture. Equipment and material shall carry Underwriters Laboratory certification if required by local, state or national codes. Products are to be from the acceptable manufacturer listed below or an approved alternate. In no case will field fabrication or “shop built” cable support products be acceptable.

2.02 UNDER SLAB CONDUIT

A. Under slab or in slab conduits 2" or larger shall be equipped with MaxCell fabric innerduct prior to installation of cabling. Unused conduits will be equipped with MaxCell fabric Innerduct for future use.

B. Provide 2" 3-Cell in 2" Conduit.

C. Provide 4" 3-Cell in 4" Conduit.

2.03 J-HOOKS

A. J-hooks shall be constructed of galvanized steel or hot dipped zinc.

B. Fastener is to be installed using dedicated wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments. Product is to be UL® Listed for the application.

C. Acceptable products: CADDY® CABLECAT – Wide Base Cable Support.

2.04 ADJUSTABLE CABLE SUPPORT SYSTEM

A. Cable support system shall be a factory produced assembly and sized to accommodate 100 percent expansion, i.e., rated to hold double the number of initially installed cables.

B. Acceptable product is: CADDY® CABLECAT Adjustable Cable Support

2.05 ROD MOUNTED CABLE SUPPORT SYSTEMS

A. Acceptable product is: CADDY® CAT-CM Cable Support System

2.06 FIRESTOPPING SYSTEMS TELECOM RACEWAYS

A. Comply with the requirements of Section 07 8400

B. Acceptable products for 2" through 4" penetrations are as follows

1. STI EasyPath™
2. Resilient elastomeric caulk and re-enterable putty manufactured by 3M™, Specified Technologies or Hilti.

C. Acceptable products for less than 2" penetrations are as follows

1. Resilient elastomeric caulk and re-enterable putty manufactured by 3M, Specified Technologies or Hilti.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install per manufacturer's instruction per weight loading.

B. Install in accordance with directions given in Section 27 0528.39

C. SMR shall be securely supported using mechanical fasteners at intervals not exceeding 10 feet or in accordance with manufacturer's installation instructions.

D. Telecommunication Outlets shall be surface mount outlet boxes compatible with the raceway specified.

E. The path of the SMR shall minimize impact on molding, tack boards and other architectural elements. Vertical runs of raceway from the ceiling to outlets shall be installed on walls near corners wherever possible. Raceway may be installed horizontally at the same height as the outlets or near to the ceiling. Entrance end fittings will be supplied at the ends of raceway runs to transition to conduit sleeves through walls, ceilings or floors. SMR shall be installed parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

F. Metal components shall be bonded and grounded in accordance with applicable code and ANSI/TIA-607-B.

G. J-hooks are to be supported by dedicated wires or rods installed by this contract. In no case will ceiling grid wires be used to support J-hooks. J-hooks will be attached to ceiling grid wires (where applicable) to satisfy seismic bracing requirements and to prevent swinging.

H. Adjustable cable support systems are to be securely attached to building structure and loaded as per manufacturer's instruction.

I. Fire Rated wall and floor penetrations shall be fire-stopped in accordance with the manufacturer's instructions using the product set referenced in 2.06 above.

END OF SECTION

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 SUMMARY

A. Section includes discrete J-Hooks, slings and related accessories for supporting low voltage cable bundles above accessible.

1.02 REFERENCES

A. American National Standards Institute (ANSI) / Telecommunications Industry Association (TIA)

1. ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
2. TIA -569-C Standard for Telecommunications Pathways and Spaces for Commercial Building
3. ANSI/NFPA 70 National Electrical Code

B. Underwriters Laboratories, Inc. (UL®)

1. UL® 2043 Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
2. UL® 2239 Conduit, Tubing and Cable Support Hardware

1.03 SUBMITTALS

A. Provide submittal information in accordance with Section 27 0500 - Common Work Results for Communications and supplementary requirements described in this specification.

B. Product Data: Submit product data on all cable support devices and accessories. Indicate materials, finishes, load ratings, dimensions, listings, approvals and attachment methods.

C. Closeout Submittals

1. As-built Drawings: Provide as-built drawings of main pathways in AutoCAD® format as per Section 27 0513.

1.04 QUALITY ASSURANCE

A. Low voltage system cable supports and accessories shall be listed to Underwriters Laboratories, Inc. Standard 2239.

B. Low voltage system cable supports and accessories shall have the manufacturers name and part number stamped on the part for identification.

C. Pre-Installation Meetings: Contractor shall set up a pre-installation meeting to discuss low voltage cable support layout work and installation guidelines. Attendees shall include Owner contractor, and appropriate subcontractors. Purpose of meeting shall be to coordinate work between the parties to have a consistent layout for all low voltage system cables, minimize interferences and to make cable system accessibility for future Owner modifications and maintenance high priority issue for all installers.

1.05 COORDINATION

A. Coordinate layout and installation of low voltage cable bundle supports with other construction elements to ensure adequate headroom, working clearance and access. Revise locations and elevations for those indicated as required to suit field conditions and as approved by Owner.

B. Particular attention is called to clearances as related to HVAC ducting and sheet metal work.

PART 2 - PRODUCTS

2.01 WIDE BASE CABLE SUPPORTS

A. J hooks - minimum size is 1-$^{5}/_{16}$ inch diameter loop for (24) 4-pair balanced twisted pair cables or equivalent strand fiber optic cable in inner duct. Provide larger size or multiple hooks where required. A minimum of 1" wide with flared edges where cables enter and leave support. A 2 inch diameter loop shall be required for (48) 4-pair balanced twisted pair cables or equivalent strand fiber optic cable or inner duct.

B. Accessories: Provide applicable accessories to independently support "J" hooks from structure. This includes extender bracket for mounting multiple J hooks on a single support, fasteners and clamps for connecting to wall, beams, rods, dedicated support wires and "C" and "Z" Purlins as required for specific construction.

C. Cable Retainers: Provide cable retainers at each "J" hook

D. Finish

1. Dry Locations, Above Lay-in Ceiling, Below Raised Floor - galvanized
2. Wet and Damp Locations: stainless steel

E. Manufacturer

1. ERICO Caddy CableCat™ series
2. Chatsworth RapidTrak™ series

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate installation with General Contractor and other trades

B. All low voltage systems cables shall be supported. Provide supports along entire Pathway.

C. Space supports a maximum of 48 inches apart and at each change of direction of the cables. In areas covered by dropped ceiling, tiles shall be left open to allow inspection by Owner.

D. Hang cable supports from $^{3}/_{8}$" all thread rods, dedicated #8 galvanized ceiling drop wire or wall brackets connected directly to structure. Do not support from the ceiling grid or ceiling wire system.

E. Where main pathways are indicated on the Drawings, contractor shall follow the indicated pathways as closely as possible according to field conditions. Pathways for smaller cable counts shall be designed and documented on the as-built drawings by the contractor.

F. Install support wires, brackets or rods to route cables parallel and perpendicular to building lines.

G. Provide multiple hooks or slings at each hanger location as required by cable count and cable segregation requirements.

H. Fill supports with cabling to 50% or less of the manufacturer's recommended fill. Provide multiple supports where required cable count exceeds 50% fill.

I. Install low voltage cable support system above accessible ceilings only.

J. Elevation of Cable Supports: Contractor shall coordinate the allocation of ceiling space and the mounting elevations to allow maintenance and accessibility for future modifications. Telecommunications cable supports shall be as close to the ceiling as possible while allowing ceiling tiles to be removed. Supports shall be located to avoid interference with maintenance access to other equipment.

K. Cable installation and supports shall comply with applicable provisions of ANSI/TIA-569-C and NFPA 70.

END OF SECTION

CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes boxes and conduits related to the installation of telecommunications cable supporting voice, data, and video (A/V and Video Surveillance) systems.

1.02 RELATED DOCUMENTS

A. Related Sections

1. Section 26 0533 - Raceways and Boxes for Electrical Systems
2. Section 27 0528.29 - Hangers and Supports for Communications Systems
3. Section 27 0528.36 - Cable Trays for Communications Systems
4. Section 27 0528.39 - Surface Raceways for Communications Systems
5. Section 27 1300 - Communications Backbone Cabling
6. Section 27 1500 - Communications Horizontal Cabling

B. Other References

1. ANSI/TIA-569-C - Commercial Building Standard for Telecommunications Pathways and Spaces
2. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

1.03 DESCRIPTION

A. Provide raceway systems for the installation of the telecommunications cables.

B. This Section shall include all raceways, outlet boxes; plaster rings and all appurtenances required for the conduits and raceways.

C. Size conduits and raceways as indicated. Where no size is indicated, conduit will be a minimum of Trade Size 1.

PART 2 - PRODUCTS

2.01 RACEWAYS

A. Except as noted below and on Drawings, components shall be as per Section 26 0533, Raceways and Boxes

B. Minimum conduit size for telecommunications outlets shall be Trade Size 1 EMT

2.02 TELECOMMUNICATIONS OUTLET BOXES

A. Comply with Section 26 0533, Raceways and Boxes

B. Wall outlets shall be 4" square, 2-$^{3}/_{4}$" deep (minimum).

2.02 OUTLET DEVICE RING

A. Provide $^{5}/_{8}$” deep single gang device (mud) ring.

2.03 DEVICE PLATES

A. Provide as per 27 1543 – Communications Faceplates and Connectors

2.04 PULL STRING

A. Shall be nylon having not less than 200-pound tensile strength.

PART 3 - EXECUTION

3.01 RACEWAYS

A. Comply with Section 26 0533, Raceways and Boxes

B. No length of run shall exceed 100 feet and shall not contain more than two 90-degree bends or the equivalent without a code size pull box. Provide pull boxes where necessary to comply with these requirements. Locate pull boxes in straight runs only, not as a replacement for an elbow.

C. Conduits with an internal diameter of two inches or less shall have a bend radius at least 6 times the internal conduit diameter. Conduits greater than two inches shall have a bend radius at least 10 times the internal conduit diameter.

D. Provide an insulated bushing on all conduits terminated in a cabinet and/ or pull boxes.

E. Terminate conduits stubbed out above accessible ceiling space so that the conduit is parallel with the ceiling and provide an insulating bushing.

3.02 PULL BOXES

A. Pull boxes shall be sized per the following table:

PULL BOX SIZING (inches)

Conduit Trade Size	Width	Length	Depth	Width increase for additional conduit
1	4	16	3	2
1-1/4	6	20	3	3
1-1/2	8	27	4	4
2	8	36	4	5
2-1/2	10	42	5	6
3	12	48	5	6
3-1/2	12	54	6	6
4	15	60	8	8

3.03 PULL STRINGS

A. Nylon type pull strings shall be included in all raceways over 10 feet long. Leave not less than 12 inches of slack at each end of the pull string.

END OF SECTION

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to completely execute a complete wire basket cable tray system as described in this specification and as shown on the Drawings.

B. Wire basket cable tray systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.

C. Material listed in this section is for use non-telecommunications room spaces. See section 27 1123 for cable tray in telecommunications room spaces.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM) International:

1. ASTM A1011 / A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
2. ASTM A123 / A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A510 - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
4. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
5. ASTM A580 – Standard Specification for Stainless Steel Wire
6. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
7. ASTM A641 / A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
8. ASTM A653 / A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
9. ASTM D769 - Standard Specification for Black Synthetic Iron Oxide

B. National Electrical Manufacturers Association:

1. NEMA FG 1 - Fiberglass Cable Tray Systems.
2. NEMA VE 1 - Metal Cable Tray Systems.
3. NEMA VE 2 - Cable Tray Installation Guidelines.

C. NFPA 70: National Electrical Code (2008)

D. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises

E. ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces

1.03 DRAWINGS

A. The Drawings, which constitute a part of these specifications, indicate the general route of the wire basket cable tray systems. Data presented on Drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

B. Specifications and Drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.04 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner's representative.

B. Supply all equipment and accessories new and free from defects.

C. Supply all equipment and accessories in compliance with the applicable standards listed in Part 1.02 of this section and with all applicable national, state and local codes.

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

E. Zinc plated wire basket cable tray shall be classified by Underwriters Laboratories (UL).

F. Wire basket cable tray shall be of uniform quality and appearance.

G. Comply with the National Electrical Code (*NEC*®), as applicable, relating to construction and installation of cable tray and cable channel systems (Article 392, *NEC*®).

H. Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.

1.05 SUBMITTALS

A. Submittal Drawings: Submit drawings of wire basket cable tray and accessories including connector assemblies, clamp assemblies, brackets, splice plates, splice bars, grounding clamps and hold-down plates showing accurately scaled components. Indicate wire basket cable tray dimensions, support points, and finishes.

B. Product Data: Submit manufacturer's data on wire basket cable tray system including, but not limited to, types, materials, finishes and inside depths.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under references. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.06 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.07 PRE-INSTALLATION MEETINGS

A. Convene a minimum of two week(s) prior to commencing work of this section. Meeting shall include General Contractor and all sub-contractors involved with the installation of duct work, plumbing or other such fixtures that will be placed in shared space above the dropped ceiling.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Ship and store wire basket cable tray system equipment in its original packages and in a clean, dry space to prevent damaging from weather, construction traffic or foreign matter. All handling performed in accordance with manufacturer's recommendations. Provide protective coverings during construction.

B. Deliver wire basket cable tray systems and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged equipment.

C. Replace at no expense to Owner, equipment or material damaged during storage or installation as directed by the Architect.

PART - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Coordinate selected product with Section 26 0536.

B. Subject to compliance with these specifications, wire basket cable tray systems to be installed shall be as manufactured by the following:

1. Cablofil® - Legrand, 60 Woodlawn Street .West Hartford, CT 06110
2. Chatsworth Products Incorporated, Chatsworth California
3. Approved equivalent

2.02 WIRE BASKET CABLE TRAY SECTIONS AND COMPONENTS

A. Provide wire basket cable tray of types and sizes indicated with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the additional construction highlighted in Section 2.02.

B. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.

C. Wire basket cable tray shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.

D. Wire basket cable tray sizes shall conform to the following nominal criteria:

1. Straight sections shall be furnished in standard 118.3 inch lengths.
2. Wire diameter shall be 0.196” (5mm) minimum on all mesh sections (minimum size of 4.5mm on stainless steel).
3. Wire basket cable tray shall have a 4 inch usable loading depth by 12 or 18 inches wide as called out on Drawings.

E. In order for a system to be approved as an equipment ground conductor (EGC), all splicing assemblies shall be UL® Classified or CSA approved as an EGC. When using powder coated wire mesh cable tray as an EGC, the paint must be completely removed at all contact points of splice/ground bolt attachments.

F. Material and Finishes: Material and finish specifications for are as follows.

1. Non-exposed cable tray shall be bright zinc plated, as manufactured.
2. In exposed areas the cable tray shall be white powder coat. Straight sections shall be powder coated with an average paint thickness of 1.2mils (30microns) to 3.0mils (75microns).

G. All fittings shall be field formed from straight sections in accordance with manufacturer’s instructions. Where exposed, white touch-up matching powder coat shall be applied to conceal bright edges.

H. Wire basket cable tray supports shall be center support hangers, trapeze hangers or wall brackets from the manufacture of the tray.

I. Trapeze hangers or center support hangers shall be supported by ¼” inch or $^{3}/_{8}$” inch diameter rods.

J. Special accessories shall be furnished as required to protect, support and install a wire basket cable tray system.

PART - EXECUTION

3.01 INSTALLATION

A. Install wire basket cable tray in accordance with NEMA VE 2 to ensure that the cable tray equipment complies with the requirements of the *NEC*®, applicable portions of NFPA 70B, and the National Electrical Contractors Association's (NECA) 'Guide to Quality Electrical Installations' pertaining to general electrical installations practices.

B. All trays should be supported using a minimum of ¼" All Threaded Rod (ATR).

C. Special accessories shall be furnished as required to protect, support and install a wire basket cable tray system.

D. Coordinate wire basket cable tray with other electrical work as necessary to properly interface installation of wire basket cable tray with other work.

E. Support trays and fasten to structure. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 5 feet maximum.

F. Install firestopping in accordance with local and NFPA regulations to sustain ratings when passing wire basket cable tray through fire-rated elements.

G. Ground and bond metal cable tray in accordance with NFPA 70, National Electrical Code Article 392: Cable Trays. Additionally;

1. Bond cable tray system to a known source of building ground.
2. Provide continuity between wire basket cable tray components. Powder coating must be thoroughly removed at grounding device connection point.
3. Make connections to tray using mechanical, compression or exothermic connectors.
4. If required, ground cable trays by mounting up to two #6 AWG bare copper wires to each wire basket cable tray section, bonded with a grounding clamp

H. Provide sufficient space encompassing wire basket cable tray to permit access for installing and maintaining cables.

3.02 TESTING

A. Test wire basket cable tray support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 20, for testing and test methods.

B. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.

END OF SECTION

SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 SECTION INCLUDES

A. Surface mounted raceway (SMR).

1.02 RELATED SECTIONS

A. Section 26 0533 - Raceways and Boxes for Electrical Systems

B. Section 27 0528 – Pathways for Communications Systems

C. Section 27 0528.29 - Hangers and Supports for Communications Systems

D. Section 27 0528.33 - Conduits and Backboxes for Communications Systems

E. Section 27 0528.36 - Cable Trays for Communications Systems

1.03 SUBMITTALS

A. Submit under provisions of Section 27 0513

B. Samples: If other than specified product is bid, Contractor must submit a 24-inch length of proposed product. Show finished detail with boxes, faceplate, connectors, angles and transitions.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacturer of raceway systems, boxes and fittings of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide fittings and boxes produced by a manufacturer listed in this section.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver raceways and distribution systems in factory labeled packages.

B. Store and handle in strict compliance with manufacturer's written instructions and recommendations

C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Provide surface mount raceway distribution components as manufactured by Panduit (TG70 Series), or approved alternate.

B. Panduit LD series is approved for runs of six or fewer cables

2.02 SURFACE MOUNTED RACEWAYS AND FITTINGS

A. General:

1. System: Surface raceway systems shall consist of bases, covers, appropriate fittings, mounting brackets, workstation boxes / enclosures and device mounting brackets and fasteners necessary for a complete installation.

2. Surface mounted raceways shall be a rectangular design with removable covers or solid construction, constructed of shatter-proof thermoplastic (or similar) raceway, utilizing elbows, couplings, and connectors of the same material.

3. Mounting Brackets: Surface mounted raceway shall be secured to wall using properly rated anchors or mounting brackets. Brackets shall provide un-obscured inspection of fastening bolts at point of wall penetration. In no case whatsoever will surface mounted raceways be attached with drywall screws.

4. Fittings: Fittings shall include flat, internal and external elbows, tees, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Provide full capacity corner elbows and fittings to maintain a controlled 2-inch cable bend radius, meeting the specification for Fiber Optic and UTP cabling and exceeding the ANSI-TIA-569-C requirements for communications pathways.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions under which raceways, boxes, distribution systems, accessories, and fittings are to be installed and substrate that will support raceways. Notify the Owner's Representative in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Strictly comply with manufacturer's installation instructions and recommendations and approved installation practices. Care should be taken to prevent "over tightening" of fastening devices.

B. The SMR shall be surface mounted on the wall using properly rated anchors or brackets. The top edge of the SMR shall be horizontally level below the suspended ceiling line or the true ceiling line, whichever is lower, shall be installed to permit visually inspection to verify the physical integrity of the raceway for its entire run, shall not block doorways or access to emergency exits, shall not inhibit the operation of windows, and shall not run across windows.

1. Support: SMR shall be supported by properly rated anchors or mounting brackets at intervals not to exceed 5 feet or in accordance with manufacturer's installation sheets.

2. Accessories: Provide accessories as required for a complete installation.

3.03 FINAL FINISH

A. All surfaces are to be left completely smooth and finished. No cut edges are to be exposed. In the event a metallic product is used, all rough edges are to be dressed and covered with appropriate fittings that prevent any access whatsoever with sharp edges.

B. The Contractor shall coordinate with General Contractor to schedule paint of metallic product to match wall. Non-metallic product shall not be painted.

3.04 CLEANING AND PROTECTION

A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.

B. Protect raceways and boxes until acceptance.

END OF SECTION

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete labeling of the telecommunications infrastructure.

1.02 SCOPE

A. This section includes all telecommunications cables and the associated infrastructure in the telecommunications rooms.

1.03 QUALITY ASSURANCE

A. All cable identification tags and labels shall be installed in a neat and workmanlike manner.

PART 2 - PRODUCTS

2.01 LABEL TAGS – CABLE AND FACEPLATES

A. The labels shall be machine generated.

B. The label background shall be white with either black or blue ink.

C. Lettering on sleeves shall be $^{1}/_{8}$-inch high

2.02 ENGRAVED SIGNAGE

A. Engraved signage shall be laminate (color as specified) with engraved white letters.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All horizontal (station) cables and outlets in which they terminate shall be identified by the Contractor at both ends of the wiring run. The standard nomenclature for the labeling is Classroom Number.Telecommunications Room Number, hereafter known as TR, at the top of the plate and the patch panel number and port number below or beside the jack insert.
2. All tie cables shall be labeled at each end. The standard nomenclature for labeling is “From <Room-1> to <Room-2>”, where “Room-1” is the originating location and “Room-2” is the destination.

B. Horizontal (Station) Cables

1. All cables will be labeled the same at both ends. The tag shall be secured to the sheath no more than 4 inches from the end of the cable. Each end of the UTP horizontal cables shall be labeled with the nomenclature “CN.P.NN”. Where CN indicates the Classroom Number, P indicates the relative position within the room, and NN indicates the port number.
2. Relative position identification shall commence to the immediate left of the entrance door with the position identifier starting at “A” and increasing through the alphabet in a clockwise direction.
3. Port numbers shall be “1” – “x”, where x is the total number of ports on a plate.

C. Copper Tie Cables

1. Cables shall be labeled “From” – “To”, specifically:

   From ER to TR-x, where “x” = TR Number

D. Fiber Tie Cables

1. Cables shall be labeled “From” – “To”, specifically:

   From ER to TR-x, where “x” = TR Number

E. Telecommunication Outlets (TO)

1. Each TO shall be labeled at the top of the modular jack enclosure with the “CN.TR” nomenclature and the jacks with the patch panel and port number beside or below.

F. Telecommunications Racks and Frames

1. Labeling in the Main Equipment Room and Telecommunications Rooms shall be as per the Drawings. Labels shall be 1” blue laminate with ½ inch white letters. Labels shall be placed left-to-right identifying “FRAME-1” through “FRAME-x”, where “x” = number of racks/cabinets present.

G. Patch Panels

1. Patch panels shall be labeled identical to the cables and telecommunications outlets.

H. Door Signage

1. The exterior door of the Main Equipment Room (ER) and Telecommunications Rooms (TRs) shall have signage as per the drawings.

END OF SECTION

COMMISSIONING OF COMMUNICATIONS

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 COMMISSIONING

A. Comply with all requirements of Section 01 1900

1.03 TESTING, IDENTIFICATION AND ADMINISTRATION

A. All cables and termination points will be tested and labeled per specifications.

B. Testing is required for this project for all copper telecommunications cables. Fiber optic testing will be as detailed below.

C. All test results shall be forwarded to the Owner's Representative for certification. Any results observed to be outside stated performance parameters shall be used by the Contractor for immediate correction.

1.04 POST INSTALLATION SERVICES

A. The Contractor shall provide on-site service as part of the warranty in the event of the failure of any installed components.

B. The contractor will provide support and warranty for installed cabling.

1. The Contractor will be the first contact point and will interface between manufacture and Owner for warranty issues.
2. The Contractor will provide the owner with contact information of the manufacture for warranty coverage prior to cable acceptance.

1.05 QUALITY ASSURANCE

A. See Section 27 0513

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. The Contractor shall provide all tools and instruments used to test the installed telecommunications signal cabling.

B. Test instruments used by the Contractor shall be suitable for the purpose at hand, and shall be of industry-recognized manufacture. Note that copper testing parameters are written for Fluke DTX-1800 or newer tester.

C. Tools leased by the Contractor are acceptable, provided the operator of the test instrument(s) has a sufficient degree of operational awareness to use the rented instrument(s) correctly and obtain test data that is both, accurate and relevant.

2.02 WARRANTY

A. All telecommunications cable installed as part of a manufacturer's certified system shall carry the manufacturer's warranty for a minimum of 20 years.

B. The manufacturer shall provide certification attesting to on-site service as part of the warranty in the event of the failure of any installed balanced twisted pair cables, fiber-optic cables, telecommunications room terminations, telecommunications outlet terminations, or cross-connect cables.

C. Such service shall be free of charge to the Owner and shall commence from the date of project acceptance and terminate not earlier than the twenty year anniversary of that date as a minimum.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS - COPPER

A. The basic link shall be tested.

B. All test results observed shall be used by the Contractor to determine any polarity and noise anomalies for immediate correction.

C. Test results shall be used jointly by the Contractor and the Owner's Representative to determine the viability of each cable for transmission in accordance with the specifications of the cable manufacturer, and the requirements imposed by the transmission system. This shall form part of the acceptance procedure for the cable plant.

D. All results obtained by use of pair-scanner testing shall be collated by TO number and presented to the Owner's Representative at the conclusion of the testing. Test compilation shall be initialed and dated by the Contractor's technician performing the test.

E. Hard copy output indicating successful testing of every location is not required; rather a diskette containing test data and the appropriate application to display such in a Windows base environment is preferred.

3.02 GENERAL TESTING PARAMETERS - COPPER

A. Categories of balanced twisted pair cable:

1. Unless otherwise designated, all station cable shall be category 6A.
2. If so noted on drawings, selected cables shall be category 5e and 6.

B. Balanced twisted pair testing shall provide certification and summary for all locations.

C. All "category" cable paths shall be tested at each jack for the following parameters and meet the requirements imposed by the ANSI/TIA-568-C.2 and the manufacture's written specification.

Category 5e and 6	**Category 6A**
Wire Map	Wire Map
Cable Length	Cable Length
Pair-to-pair NEXT	Insertion Loss
Power Sum NEXT	Next Loss
Attenuation	PS Next Loss
Pair-to-Pair ELFEXT	ACR-F Loss
Power Sum ELFEXT	PS ACR-F Loss
Return Loss	Return Loss
Propagation Delay	Propagation Delay
Delay Skew	Delay Skew

3.03 ADDITIONAL CATEGORY 6A TESTING PARAMETERS

A. In addition to testing the "In-link" performance parameters detailed in A.1 above, Alien Crosstalk testing or "Between-link' testing shall be carried out in accordance with Section 4.7 of ANSI/TIA-1152. Alien crosstalk testing includes the PS ANEXT and PS AACR-F (Power sum alien attenuation-to-crosstalk ratio from the far end) performance parameters. The standards refer to the link-under-test for Alien Crosstalk as the *disturbed* link.

B. PS ANEXT and PS AACR-F shall meet or exceed the limits defined in Section 6 of ANSI/TIA-568-C.2.

1. Selection of disturbed (victim) links:

Installation size (No. of total links)	Sample size (No. of links to test)
3 – 33	100%
34 – 3,200	33
3,201 – 35,000	126
35,001 – 150,000	201
150,001 – 500,000	315

2. Choose short, medium and long links equally.

3. Selection of disturber links. Select all of the links that are in the same cable bundle and the most consistently positioned relative to the disturbed link as disturbing links.

C. If the margin of PS NEXT and PS ACR-F exceeds 5 dB for the first three short, medium and long links (nine in total), further alien crosstalk testing can be discontinued.

D. The installed twisted-pair horizontal links shall be tested from the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "*Permanent Link*" performance specification as defined in the TIA Cat 6A Standard.

E. One hundred percent of the installed cabling links must pass the requirements of the standards mentioned in above and as further detailed in Section 3.04 below. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section 3.05 below.

F. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals).

G. The test equipment (tester) shall comply with the accuracy requirements for level IIIe field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy *plus* adapter contribution) are specified in Table 4 of ANSI/TIA-1152 (Table 4 in this TIA document also specifies the accuracy requirements for the Channel configuration).

H. The eight-pin modular (RJ45) test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.

I. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

J. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

K. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any “Fail” or “Fail*” result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must “Pass” or “Pass*”.

L. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent '*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

3.04 PERFORMANCE TEST PARAMETERS FOR BALANCED TWISTED PAIR

A. **Wire Map**

Report “Pass” if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

B. **Length**

The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation (NVP)[1] The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.

C. **Insertion Loss (Attenuation)**

Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz through 250MHz for category 6 and 1 through 500 MHz for category 6A in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

D. **NEXT Loss**

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 250MHz for category 6 and 1 through 500 MHz for category 6A. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair.

The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the standard as shown in Table 1. . Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin[2] ***and*** the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

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1 Nominal Velocity of Propagation (NVP) expresses the speed of the electrical signals along the cabling link in relation to the speed of light in vacuum ($3x10^8$ m/second). Insulation characteristics and twist rate of the wire pair influence NVP in minor ways. Typically, an ‘average’ value for NVP is published for all four wire-pairs in a data cable.

2 ‘Margin’ designates the difference between the measured value and the corresponding test limit value. For passing links, ‘worst case margin’ identifies the **smallest** margin over the entire frequency range; the point at which the measured performance is “closest” to the test limit.

Frequency Range (MHz)	Maximum Step Size (MHz)
1 - 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50
250 - 500	1.00

Table 1 -- Maximum frequency step size as defined in ANSI/TIA-1152

E. PS NEXT Loss

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through250MHz for category 6 and 1 through 500 MHz for category 6A and the step size may not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

F. ACR-F, pair-to-pair

Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured from 1 through 250MHz for category 6 and 1 through 500 MHz for category 6A and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard as in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

G. PS ACR-F Loss

Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results):

Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

H. Return Loss

Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured form 1 through 250 MHz for category 6 and 1 through 500 MHz for category 6A in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

I. Propagation Delay

Propagation delay is the time required for the signal to travel from one of the link to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

J. **Delay Skew** (as defined in the ANSI/TIA-568-C.2; Section 6.2.19)

This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

K. PS ANEXT

Pair-to-pair Alien NEXT (ANEXT) contributions is measured by applying the stimulus signal at the near end to one wire pair of a disturbing link and measuring the coupled signal at the near end of a wire pair in a disturbed link. This process is repeated for every wire pair in a disturbing link. The PS ANEXT for each wire pair in a disturbed link is obtained by the power sum addition of all the pair-to-pair ANEXT results to that wire pair from all wire pairs in disturbing links. All the links that are bundles with the disturbed link need to be included as disturbing links. In addition, links that are terminated in adjacent positions in a patch panel or interconnect panel should also be included as disturbing links in this test.

Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS ANEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

L. PS AACR-F

The pair-to-pair Alien Far End crosstalk (AFEXT) contributions is measured by applying the signal at the near end to one wire pair of a disturbing channel or permanent link and measuring the coupled signal at the far end of a wire pair in a disturbed channel or permanent link. This process is repeated for every wire pair in a disturbing link and for all links in close proximity. A normalization, which is dependent on the relative length of disturbing and disturbed link, is applied to each pair-to-pair alien FEXT measurement. Then the PS Alien Attenuation-to-Crosstalk Ratio from the Far end (PS AACR-F) for each wire pair in a disturbed channel or permanent link is obtained by the power sum addition of all the normalized pair-to-pair far end alien crosstalk results to that wire pair from all wire pairs in disturbing links in close proximity.

Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS AACR-F. If the link or channel connects two patch panels (data center), these wire pairs must be identified for the tests performed from both ends. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

3.05 TEST RESULT DOCUMENTATION

A. The test results/measurements shall be transferred into a Windows based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.

B. The database for the completed job shall be stored and delivered on magnetic media including the software tools required to view, inspect, and print any selection of test reports.

C. Test results shall be provided that lists all the links that have been tested with the following summary information

1. The identification of the link in accordance with the naming convention defined in the overall system documentation
2. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
3. The date and time the test results were saved in the memory of the tester.

D. General Information to be provided in the electronic data base with the test results information for each link:

1. The identification of the customer site as specified by the end-user
2. The identification of the link in accordance with the naming convention defined in the overall system documentation
3. The overall Pass/Fail evaluation of the link-under-test
4. The name of the standard selected to execute the stored test results
5. The cable type and the value of NVP used for length calculations
6. The date and time the test results were saved in the memory of the tester
7. The brand name, model and serial number of the tester
8. The identification of the tester interface
9. The revision of the tester software and the revision of the test standards database in the tester
10. The test results information must contain information on each of the required test parameters that are listed in Section 3.04 and as further detailed below under paragraph E & F.

E. In-link (In-Channel) detailed test results. The detailed test results data to be provided in the electronic database for must contain the following information:

For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.

- **Length**: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m and the test limit value
- **Propagation delay**: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value
- **Delay Skew**: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value
- **Insertion Loss (Attenuation)**: Minimum test results documentation as explained in Section B for the worst pair
- **Return Loss**: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link
- **NEXT, ACR-F**: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link
- **PS NEXT and PS ACR-F**: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

F. Between-Link (Between-Channel) Test Results Data

A test report shall be provided for each disturbed link included in the Alien Crosstalk sample test. This test report must contain

1. PS ANEXT results at each frequency (See Table 1 above) for each wire pair in a victim link as well as the PS ANEXT results for the average of these four wire pairs. The worst case margin and the worst values shall be provided for each wire pair and the average of the four wire pairs. PS ANEXT shall be measured and tested from the end of the link or channel where all cables are terminated at a distribution panel. In case the cabling runs from panel to panel (data center) where the worst case PS ANEXT margin is less than 2 dB, the PS ANEXT test results for each disturbed link shall be collected and saved from both ends (both panels) of the disturbed link.
2. PS AACR-F results at each frequency tested (See Table 1) for each wire pair in a disturbed link as well as the PS AACR-F results for the average of the four wire pairs. The worst case margin and the worst values shall be provided for each wire pair and the average of the four wire pairs. PS AACR-F only needs to be measured and tested from one end of the link or channel. Connect the main DTX-1800 unit (measurement of PS AACR-F disturbance) to the disturbed link or channel at the end where all cabling links are terminated at a distribution panel. Select End 1 in the AxTalk Analyzer Software.

3.06 GENERAL TESTING REQUIREMENTS – FIBER OPTIC BACKBONE CABLES

A. Test reference cords (TRC) shall be used when testing all fiber. Loss for TRCs shall be:
   1. ≤ 0.1 dB for multimode
   2. ≤ 0.2 dB for multimode

B. All fiber cable paths shall be tested utilizing a power meter to determine the following:
   1. Loss at 850 and 1310 nanometers (multimode) and 1550 nanometers (single mode)
   2. Cable length

C. Single mode fiber shall be tested in accordance with ANSI/TIA-568-C Method A.1

D. Test shall be conducted end-to-end, including connectors.

E. Contractor shall provide results from power meter testing of fiber optic cable to attest to proper polarity and end-to-end performance of the installed fiber.

F. Contractor shall provide for the Owner's Representative as part of the as-built documentation all factory test results shipped with the fiber.

END OF SECTION

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL REQUIREMENT

1.01 SECTION INCLUDES

A. Construction Requirements

B. Site Specific Requirements

1.02 RELATED SECTIONS

A. Section 27 0526 – Grounding and Bonding for Communications Systems

B. Section 27 0528 – Pathways for Communications Systems

C. Section 27 0528.29 - Hangers and Supports for Communications Systems

D. Section 27 0528.33 - Conduits and Backboxes for Communications Systems

E. Section 27 0528.39 - Surface Raceways for Communications Systems

F. Section 27 0553 – Identification for Communication Systems

G. Section 27 1116 – Communications Cabinets, Racks, Frames and Enclosures

H. Section 27 1123 – Communications Cable Management and Ladder Rack

1.03 CONSTRUCTION REQUIREMENTS

A. This contract is responsible for the build out of the telecommunications spaces to include telecommunications rack(s), Uninterruptable Power Systems (UPS), ladder racking and all required rack and cabinet power distribution emanating from the UPS.

1.04 SITE SPECIFIC REQUIREMENTS

A. As a part of this project, the Main Equipment Room (ER) and Telecommunications Rooms (TR) will be constructed as shown on the Drawings. This contract will be responsible for procurement and installation of all components from the plywood backboards out, i.e., installation of required racks, ladder tray, bonding and grounding and other ancillary equipment as shown on the Drawings or deemed necessary for the operation of a complete system.

PART 2 - PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and model or catalog number herein is for the purpose of establishing the product set, which the Contractor is to supply and install.

B. Quantities are to be determined by Contractor unless specified.

2.02 PRE-APPROVED PRODUCT SETS

A. The following product set is approved for this project. The District will not accept substitution requests for these components.

1. Racks, cabinets, enclosures, frames and associated fastening devices shall be from Chatsworth Products Incorporated (CPI)

PART 3 - EXECUTION

3.01 GENERAL

A. Manufacturer's installation instructions and requirements shall be strictly adhered to in the telecommunications equipment installation, fabrication and testing process.

B. Where conflicts arise between the requirements of this Specification and the manufacturer's installation instructions, the Owner’s Representative shall be consulted for resolution.

C. Equipment shall be firmly held in place. Fastenings, supports, and hangers shall be adequate to support their loads. Fasteners are to be a minimum of Grade 5 and constructed of stainless steel or zinc plated steel. In no case will drywall screws be accepted as permanent fasteners.

D. The installation must conform to OSHA standards and comply with state and local safety codes.

E. Installation shall be neat, well organized, and professional.

F. The Contractor shall clean up the work area at the end of each day. At the end of the project all material removed or left over, and/or not being used shall be removed from the project site unless other arrangements have been made. A final clean up shall be made before final payment is made.

G. All wall and penetrations shall be fire stopped at or before substantial completion.

3.02 PREPARATION

A. Before commencing work, the Contractor shall field-investigate each facility and ascertain if the physical and electrical conditions within the facility shall permit commencement of the Contractor's work.

B. Plywood backboards must be painted prior to installation of cabinets or any racking that will bolt to the plywood.

C. Any discrepancies, questions, or concerns noted at that time should be brought to the immediate attention of the Owner’s Representative.

3.03 COMPONENT INSTALLATION

A. All equipment is to be bonded as per Section 27 0526

B. Install all telecommunications cabinet and racking materials in accordance with Sections 27 1116 and 27 1123.

END OF SECTION 27 1100

COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL REQUIREMENT

1.01 SECTION SCOPE

A. This section outlines the minimum requirements for equipment racks, cabinets, and enclosures.

B. This section outlines labeling requirements for racks and cabinets.

C. Deferred submittals for seismic zone 3 will be required to be submitted by the Contractor and approved by the AHJ prior to installation of equipment listed in this section.

PART 2 - PRODUCTS

2.01 GENERAL

A. Products and part numbers specified are from Chatsworth Products Incorporated (CPI).

2.02 TELECOMMUNICATIONS RACK

A. Freestanding telecommunications racks shall be installed in the Telecommunications Rooms as per the Drawings.

B. Racks shall be Chatsworth 7’ x 19”. Part number shall be 55053-703.

C. Chatsworth 3” channel rack-to-runway mounting plate with bracket. Part number shall be 10595-712.

D. Chatsworth cable runway radius drop, Part number shall be12100-712.

2.03 TELECOMMUNICATIONS RACK – FOUR POST

A. A four-post server racks shall be installed in the Main Telecommunications Equipment Room as per the Drawings.

B. Racks shall be Chatsworth 7’ x 19” x 40” (D), Part number shall be 15214-703.

C. Chatsworth Runway Mounting Bracket, Part number shall be 15205-701.

D. Chatsworth Equipment Support Rails, Part number shall be 15235-706.

2.04 LABELING

A. Telecommunications Racks and Frames

1. Labeling in the Main Equipment Room and Telecommunications Rooms shall be as per the Drawings. Labels shall be 1 inch tall blue laminate with ½ inch white letters. Labels shall be placed left-to-right identifying “FRAME-1” through “FRAME-x”, where “x” = number of racks/cabinets present.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS -

A. Racks shall be firmly affixed to the floor using anchors and Grade 5 bolts.

B. Top of rack shall be firmly affixed to ladder tray by means of a mounting plate as detailed in Section 27 1123.

C. Rack shall be bonded to adjacent assemblies as detailed in Section 27 0526.

D. All metallic components shall be bonded as per 27 0526.

END OF SECTION 27 1116

COMMUNICATIONS TERMINAL BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other Division 1 – General Requirements sections, apply to the work specified in this section

1.02 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment, including all support structure whether called out for or not, required for the complete installation of work called for in the Contract Documents

B. Install utility supply and special circuit's cables, riser blocks, patch panels, and all support structure in the Equipment and Telecommunication Rooms as outlined on drawings and specifications.

1.03 SECTION INCLUDES

A. This Section addresses the termination of copper backbone and station cables which are to be placed between the Main Equipment Room (ER) and the Telecommunications Rooms (TRs) located throughout the building. Included is all equipment and materials required to allow the Telecommunications Rooms to support all associated serving zones and connect it to the main Equipment Room backbone.

1.04 QUALITY ASSURANCE

A. All equipment shall be installed in a neat and workmanlike manner.

B. All materials shall be installed per standard installation practices and manufacturer's specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. All products must be new and UL Listed for their use.

2.02 PUNCHDOWN BLOCKS

A. 100 pair 110 type punch down blocks with legs.

B. 5 pair connecting clips

2.03 PATCH PANELS

A. 8-pin modular Category 5e 24 or 48 port for access control applications.

B. 8-pin modular Category 6 (Copper Risers) 24 or 48 port for voice and utility applications.

C. 8-pin modular Category 6A (Station Cables) 24 or 48 port for data cabling.

PART 3 - EXECUTION

3.01 GENERAL

A. All 110 blocks shall be installed as per the detail provided on the Drawings.

B. All patch panels supporting the copper backbone cabling shall be installed in 7' x 19" equipment racks in the ER and TRs.

3.02 INSTALLATION

A. 110 blocks shall be labeled as per criteria provided on Drawings and Section 27 0553

B. A one RMU horizontal wire management panel shall be installed at the top of each rack used for copper backbone cables. Additional horizontal wire management shall be installed at a rate of one RMU per each 24 port panel installed.

3.03 PATCH PANELS

A. Patch Panels shall be installed in equipment racks.

B. Patch panels shall be installed per manufacturer's instruction and as indicated in drawings and specifications.

END OF SECTION 27 1119

COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

B. Install ladder racks, cable trays, and all support structure in the Equipment and Telecommunication Rooms as outlined on drawings and specifications.

C. Equipment installed shall include:

1. ladder trays,
2. vertical cable management,
3. brackets and support pieces, and
4. All related materials required to provide cable management and transition pathways within the Equipment and Telecommunications Rooms of this project.

D. Material listed in this section is for use within the telecommunications rooms. See section 27 0528.36 for cable tray in non-telecommunications room spaces.

1.02 RELATED SECTIONS

A. Section 27 1100 – Communications Equipment Room Fittings

B. Section 27 1116 – Communications Cabinets, Racks, Frames and Enclosures

1.03 QUALITY ASSURANCE

A. All equipment shall be installed in a neat and workmanlike manner.

B. All materials shall be installed per standard installation practices and manufacturer's specifications.

1.04 SEISMIC CONSIDERATIONS

A. All equipment must meet or exceed the requirements of Seismic Zone 3 and satisfy the AHJ for suitable components.

B. Contractor shall submit stamped shop drawings as deferred submittals to AHJ.

C. Contractor shall provide evidence of submittals and satisfactory compliance from AHJ.

PART 2 - PRODUCTS

2.01 GENERAL

A. Chatsworth Products Incorporated (CPI) are the only approved products for this Section.

B. Attachment hardware not supplied in kits from manufacturer shall be Grade 5 or greater.

2.02 CHANNEL RACK-TO-RUNWAY

A. Use a Channel Rack-to-Runway Mounting Plate Kit to securely attach 12" wide cable tray to equipment rack. A kit from Chatsworth includes all necessary bolts, washers, and nuts to make the attachments. CPI Part 12730-712

2.03 HORIZONTAL WIRE MANAGEMENT

A. Horizontal cabling managers shall be used to organize and contain patch cord runs from patch port to vertical cable wire management. Manufacturer to be same as structured cabling system.

B. Double (3.5') RMU units only are acceptable and are to be supplied at the rate of 1 RMU per each 24 ports of patch panel.

2.04 CABLE TRAYS WITHIN TELECOM ROOMS

A. The telecommunications cable tray shall be 12” wide universal cable runway. CPI 10250-712

B. End caps, CPI Part Number 10642-001 as required

C. Cable runway radius drop, CPI 12100-712

D. Butt splices, as required, will be accomplished using CPI 11299-701

E. Ninety degree junctions will be accomplished using CPI 11298-701

F. Wall Angle Support Kit shall be 12” wide for attaching cable tray perpendicular to the wall. CPI 11421-712

G. Grounding straps shall be CPI 40164-001 (available in lots of 25 each as CPI 40164-025)

2.05 VERTICAL WIRE MANAGEMENT

A. Two post racks shall be equipped with a double sided 7 foot vertical cable manager on each side of the rack. Chatsworth part number 11729-709.

B. Four-post racks shall have single sided 7 foot vertical cable managers as shown on drawings, Chatsworth part number 11730-703.

2.06 EQUIPMENT SHELF

A. Provide one equipment shelf for each rack (two and four post). Chatsworth part number 40074-700

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment Racks

1. Equipment racks shall be equipped with a mounting plate suitable for securing a 12-inch width cable tray from the rack to the backboard.
2. A two RMU horizontal wire management panel shall be installed at the top of the rack. Additional horizontal wire management shall be installed as described above.
3. Bolts used to attach the rack to the floor shall be stainless steel or zinc coated steel. Fasteners shall be Grade 5 or higher

B. Cable Tray

1. The cable tray shall be installed as per Drawings to support cable runs from equipment rack to wall connections.
2. Appropriate vertical wall brackets, support brackets, and splice kits are to be used when securing the runway.

C. All racks and associated components shall be grounded in accordance with ANSI/TIA-607-B, National Electric Code®, and the Authority Having Jurisdiction.

D. This contract is responsible for satisfying all requirements pertaining to seismic compliance. All inspections or engineering associated with seismic compliance shall be included in this contract at no additional cost to the Owner.

END OF SECTION 27 1123

COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

PART 1 - GENERAL REQUIREMENT

1.01 DESCRIPTION OF WORK

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Install Uninterruptable Power System (UPS) as per documents and Drawings.

C. Provide and install power distribution as per documents and Drawings.

D. Install network management card(s) and verify connectivity to Owner's network.

1.02 QUALITY ASSURANCE

A. All equipment shall be installed in a neat and workmanlike manner.

B. All materials shall be installed per standard installation practices and manufacturer's specifications.

C. Verify input plug configuration for UPS system is coordinated with Div 26.

D. Verify input plug configuration for power distribution units is compatible with the UPS in each telecom room.

PART 2 - PRODUCTS

2.01 GENERAL

A. Quantities are to be as called out on Drawings.

B. All products must be new and UL Listed for their use.

2.02 UNINTERRUPTABLE POWER SYSTEMS

A. 2200VA UPS – Approved are:

1. APC Smart-UPS RT 2200VA - Rack Mounted 120V, APC Part Number SURTA2200RMXL2U.

B. 3000VA UPS - Approved are:

1. APC Smart-UPS RT 3000VA - Rack Tower 120V, APC Part Number SURTA3000RMXL3U

C. 5000VA UPS – Approved are:

1. APC Smart-UPS RT 5000VA RM 208V to 208/120V, APC Part Number SUA5000R5TXFMR.

2.03. ENVIRONMENTAL MONITORING AND NETWORK INTERFACE MODULE

A. All UPS units will be equipped with a network management card with environmental monitoring. Approved are:

1. APC Part Number AP9631.

2.04 POWER DISTRIBUTION UNITS

A. One per rack in all Telecommunications Rooms. - Approved are:

1. Rack PDU, Basic, Zero U, 15A, (14) 5-15, APC Part Number AP9567
2. Rack PDU, Knurr DI Strip, 15A, (12) 5-15, Part Number 035351021

PART 3 - EXECUTION

3.01 GENERAL

A. Follow manufacturer's instruction in terms of moving and mounting. These units will, in all likelihood, require two people to safely mount into the prescribed racks/cabinets.

B. Bond all TVSS components as per manufacturer's instruction.

C. Units are to be powered on and batteries fully charges prior to any load testing whatsoever including the energizing of Owner supplied active electronics.

3.02 INSTALLATION

A. 2000/2200VA

1. UPS to be installed in lowest position of rack in the TR.
2. UPS to be installed in the lowest position of the wall mounted cabinets.
    a. The input for the UPS 120 Volt, 20 amps and requires a NEMA 5-20 receptacle.
3. Rack PDU – install one on each side on rear rails with supplied brackets in the rack allocated to Owner Supplied / Active Electronics. Energize from UPS.
4. Network Management Card – install in each UPS. Connect to designated port on District supplied Ethernet switch. Verify link light on card.

B. 3000VA

1. UPS is to be placed in the bottom most position of the four-post rack in the Main Equipment Room.
    a. The input for the UPS 120 Volt, 30 amps and requires a NEMA L5-30 receptacle. This Contract is responsible for and must coordinate with Electrician for placement of this receptacle.
2. Rack PDU – install one on each side on rear rails with supplied brackets in the rack allocated to Owner Supplied / Active Electronics. Energize from UPS
3. Route network interface cable and output power cables in overhead ladder tray.
4. Network Management Card – install in each UPS. Connect to designated port on District supplied Ethernet switch. Verify link light on card.

C. 5000VA

1. UPS is to be placed in the bottom most position of the four-post rack in the Main Equipment Room (MDF) and the four-post rack in the IT Area.
    a. The input power for these units is 208/240 Volt. The APC comes with an 8 foot power cord and requires a NEMA L6-30R receptacle. The Liebert unit is designed to be hard wired. This contract is responsible for selection of the proper method of power to match the unit selected. This contact must coordinate with electrician for placement of receptacle or in the case of hard wire, coordinate the 208/240 Volt connection.
2. Rack PDU – spaced across the rear of the racks with supplied brackets in the rack(s) allocated to Owner Supplied / Active Electronics. Energize from UPS.
3. Route network interface cable and output power cables in overhead ladder tray.
4. Network Management Card – install in UPS. Connect to designated port on District supplied Ethernet switch. Verify link light on card.

END OF SECTION 27 1126

COPPER BACKBONE CABLING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 SCOPE

A. This section includes the copper backbone cable and the termination requirements.

B. A multi-pair cable shall be installed between the Main Equipment Room (ER) and each Telecommunications Room (TR). Cables shall be terminated on 110 blocks mounted in the ER and extended to rack mounted 24-port patch panels in each of the TRs.

1.03 QUALITY ASSURANCE

A. See Section 27 0513

B. All cable shall be installed in a neat and workmanlike manner.

PART 2 - PRODUCTS

2.01 UTILITY SUPPLY CABLE

A. The utility supply cable shall be twelve, category 6, 4-pair unshielded twisted pair cables.

B. The cable shall be 22-24 AWG with a jacket rated for installation in under-slab ducts.

2.02 PATCH PANEL

A. Utility Supply, 48 port panel, rated for Category 6.

2.03 110 BLOCKS

A. 200 pair with legs utilizing C-5 clips at the MDF only.

PART 3 - EXECUTION

3.01 GENERAL

A. Cable ties must be finger tight. The cable tie must not distort the outer jacket.

B. The bend radius shall be no less than 10 times the outside cable jacket.

C. Only Velcro®-type wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication and Equipment Rooms.

3.02 PREPARATION

A. Conduits

1. Outside plant cable shall be installed in a Trade Size 4 conduit placed by others. Pull string shall be available for use by this contract.
2. All conduits and sleeves shall be inspected for bushings prior to cable installation.
3. Missing bushings shall be brought to the attention of the owner or authorized representative.

3.03 INSTALLATION

A. Copper Riser Cable

1. Cables shall be installed between punch down blocks in the Main Equipment Room (MDF) and Telecommunications Rooms (IDFs).
2. The punch down side of the cable shall be terminated 110 blocks with C-4 clips. 110 blocks are to be placed on the telecommunications backboard in the main equipment room as per the drawings.
3. 48 port utility supply patch panels shall be placed as per the Drawings in each of the Telecommunications Rooms.
   a. Provide (1) in the MDF and (1) in each of the IDFs.
4. Place twelve cables from the 110 block in each room to the patch panel. Terminate one pair per port.
5. Provide a 25-pair category 3 cable in the MDF to the Service Provider 110 block as shown on detail 2 of sheet T702.

B. Label 110 blocks and patch panels “UTILITY FEED TO IDF-x”, where X = IDF Number, specifically “IDF-2”, “IDF-2” or “IDF-4”

END OF SECTION 27 1313

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 SCOPE

A. This section includes the fiber backbone cable and the termination requirements.

1.03 QUALITY ASSURANCE

A. See Section 27 0513

B. All cable shall be installed in a neat and workmanlike manner.

PART 2 - PRODUCTS

2.01 FIBER OPTIC CABLE

A. Fiber optic cable is approved for use with the Distributed Antenna System. Fiber for Distributed Antenna System shall be installed by others as part of the requirements of Section 275319 based on contractor design. Fiber distribution units for the DAS system shall match the components listed in 2.04 below.

B. Multimode fiber shall be 50/125μm Laser Optimized multimode (OM3). Singlemode fiber shall be 8/125μm (OS1). Strand count shall be as per Drawings. Rating shall be suitable for applications with a minimum rating of OFNR. Factory terminated, pre-connectorized assemblies are preferred.

C. This contract shall place a 24-strand single mode fiber between this facility and Spencer View Housing MDF. Route and details are provided on Drawings.

D. Fiber assemblies shall roll within the wall as per ANSI/TIA-568-C.3, Type-C. The final fiber sequence will be as follows:

1. In building 12-strand Multimode

End	Fiber sequence for multimode fiber(delivered at the LC connector)											
MDF	1	2	3	4	5	6	7	8	9	10	11	12
IDF	2	1	4	3	6	5	8	7	10	9	12	11

2. 24-strand Single Mode tie cable to Spencer View Housing

MDF	1	2	3	4	5	6	7	8	9	10	11	12
IDF	2	1	4	3	6	5	8	7	10	9	12	11

MDF	13	14	15	16	17	18	19	20	21	22	23	24
IDF	14	13	16	15	18	17	20	19	22	21	24	23

2.03 READER BOARD FIBER

A. This contract will place a four-strand multimode fiber between the MDF and the Reader Board. A Trade Size 2 conduit will be installed by others as a pathway for the fiber and innerduct.

2.04 FIBER OPTIC TERMINATION

A. Fiber termination equipment will be:

1. 2U frame. Approved is Panduit part number FRME2U. Place one in each IDF. Two will be required in the MDF. One shall be used to land fiber from the IDF locations (multimode) and the other shall be used to land the single mode fiber from Spencer View Housing MDF.
2. Multimode fiber shall terminate on LC fiber adapter panels. Approved is Panduit part number FAP6WAQDLCZ. Quantities as required

3. Single mode fiber shall terminate on LC Fiber adapter panels. Approved is Panduit FAP12WBULCZ
4. Blank panels shall be used to cover all unused openings in the frames. Approved is Panduit part number FAPB.
5. Reader board fiber will be terminated as follows:
   i. Terminate fiber using duplex LC connector modules. Approved is Panduit part number CMDJAQLCZBL.
   ii. Place fiber modules in surface mount box. Approved is Panduit UICBX4IW-A.

PART 3 - EXECUTION

3.01 GENERAL

A. Cable ties must be finger tight. The cable tie must not distort the outer jacket.

B. The bend radius shall be no less than 10 times the outside cable jacket.

C. Only Velcro®-type tie wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication and Equipment Rooms.

3.02 PREPARATION

A. Conduits - all conduits shall be inspected for bushings prior to cable installation.

3.03 INSTALLATION

A. Install per manufacturer's instructions.

B. Install the fiber optic cable by hand or by using a mechanical pulling machine. If a mechanical pulling machine is used, equip the machine with a monitored or recording tension meter. Ensure that at no time the manufacturer's recommended maximum pulling tension is exceeded. Ensure that the central strength member and aramid yarn are attached directly to the pulling eye during cable pulling. Use pulling attachments, such as "basket grip" or "Chinese finger" type, to ensure that the optical and mechanical characteristics are not degraded during the fiber optic cable installation.

C. Ensure that excess cable is coiled in a figure eight and fed manually when pulling through pull boxes and splice boxes by hand. If pulleys and sheaves will be used to mechanically pull through pull boxes and splice boxes, provide a drawing of the proposed layout showing that the cable will never be pulled through a radius less than the manufacturer's minimum bend radius. Use large diameter wheels, pulling sheaves, and cable guides to maintain the appropriate bend radius. Provide tension monitoring at all times during the pulling operation. Ensure that cable pulling lubricant used during installation is recommended by the optical fiber cable manufacturer.

D. Label fiber patch panels in the MDF as: "Feed to IDF-x", where x = IDF number

E. Label fiber patch panels in the IDF as "Feed from MDF"

F. Coordinate placement of fiber within the Reader Board with General Contractor.

G. Place Reader Board surface mount box on backboard in MDF. Provide a 20' slack coil of fiber. Label fiber and mounting box as "READER BOARD".

END OF SECTION 27 1323

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Install horizontal cable as outlined on drawings and specifications. Also included is sleeves for any ceiling or wall penetrations not provided by the General or Electrical Contractor; fire stopping as directed by the most stringent of these specifications or code; and all support structure needed to install the above components.

C. Verify actual counts on prints and drop detail.

1.02 SCOPE OF WORK

A. It is the intent of this section for the Contractor to provide a complete workable cabling system ready for the Owner's use in accordance with the latest current version of ANSI/TIA-568 standards to support high speed data applications up to 10Gbs including IEEE 802.3x system standards.

1.03 QUALITY ASSURANCE

A. All cable shall be installed in a neat and workmanlike manner.

B. Strictly adhere to all category 6A installation practices when installing horizontal cabling.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Section 27 0513 for General Requirements.

B. The horizontal UTP cabling system shall be a Category 6A warranted link system, including the patch cords, patch panels, cables, and telecommunications outlets.

2.02 COPPER CABLE

A. The horizontal copper cable supporting all locations except as noted on Drawings, shall be 4-Pair balanced twisted pair rated for category 6A. Color to be dark blue.

B. Cable supporting locations identified as Wireless Access points (WAP) and so noted as a circled “W” on the Drawings, shall be 4-Pair balanced twisted pair rated for category 6A. Color to be yellow.

C. Cable called out as category 5e shall be shall be 4-Pair balanced twisted pair. Jacket shall be white in color.

D. Backbone cable shall be 4-Pair balanced twisted pair rated for category 6. Jacket shall be rated for wet locations and black in color. Refer to Section 27 1313.

PART 3 - EXECUTION

3.01 GENERAL

A. Cable termination shall be as per Sections 27 1119 and 27 1543.

B. Cable ties must be finger tight. The cable tie must not distort the outer jacket.

C. The bend radius shall be no less than 4 times the outside cable jacket diameter for the horizontal UTP cable and 10 times the outside cable jacket diameter for both the fiber and multi-pair copper riser cable.

D. Only Velcro® (hook and loop) type cable wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication and Rooms.

3.02 PREPARATION

A. Conduits

1. All conduits and sleeves shall be inspected for bushings prior to cable installation.
2. Missing bushings shall be brought to the attention of the owner or authorized representative.

3.03 INSTALLATION

A. Copper Horizontal Cables

1. Installation shall be in a manner to meet the specifications as outlined by the cable manufacturer for the product set being installed.
2. Copper horizontal cables shall be pulled from the TR to the workstation.
3. Service loops of
   a. 10 feet minimum shall be left coiled high as high as possible in the MDF or IDF.
   b. 10 feet of slack shall be neatly coiled and secured with Velcro® at the telecommunications outlet (typically in the ceiling) used for Wireless Access points
   c. Placement of service loops subject to verification by Owner.
4. Location and label shall be annotated on the as built drawings.
5. Locations coiled for wireless shall have ½" black on white labels placed below the outlet on the ceiling grid.

END OF SECTION 27 1513

COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL REQUIREMENT

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.03 QUALITY ASSURANCE

A. See Section 27 0513

B. All faceplates shall be installed in a neat and workmanlike manner.

PART 2 - PRODUCTS

2.01 OUTLET FACEPLATE

A. Standard Telecommunications Outlet shall be a four port faceplate with three 8 pin modular jacks and one blank insert. Color shall be gray.

B. Exceptions (as shown on Drawings) will require differing count/port faceplate and 8 pin modular jacks.

2.02 TERMINATION – WAP

A. Termination for cables supporting WAPs is to be made using a white category jack. Each WAP location shall be two cables placed in a white, single gang box with 2-port faceplate.

B. Termination shall provide a 20 foot slack loop to be coiled and secured with Velcro®. Biscuit box shall be affixed to structure.

2.03 OUTLET JACK

A. The termination jack for the standard connections shall be an 8-pin (4 pair) modular jack T568A rated for category 6A. Jacks shall be different colors and installed as follows:

1. Upper left – black
2. Upper right – gray
3. Lower left – gray
4. Lower left - blank

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install faceplates as per manufacturer's instructions. Care must be taken to provide a plumb and level appearance.

B. WAP locations shall be labeled on the dropped ceiling or wall in a manner that is clearly visible ($^1/_2$" black on white label) and allows Owner to quickly determine which ceiling panel covers the WAP.

END OF SECTION 27 1543

COMMUNICATIONS PATCH CORDS AND STATION CORDS

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 QUALITY ASSURANCE

A. See Section 27 0513

PART 2 - PRODUCTS

2.01 FIBER PATCH CORDS - MULTIMODE

A. The Contractor shall supply the fiber-optic patch cords in the quantities listed. Each patch cord shall be a duplex LC connector to duplex LC connector. The patch cords shall be made from Laser Optimized (OM4) 50/125μm multimode fiber and shall be aqua in color.

Length	1M	2M	3M
Quantity	10	4	4

2.02 FIBER PATCH CORDS – SINGLE MODE

A. The Contractor shall supply single mode patch cords in the quantities listed. Each patch cord shall be a duplex LC connector to duplex LC connector. The patch cords shall be yellow in color.

Length	1M	2M	3M
Quantity	4	4	4

2.03 COPPER PATCH CORDS

A. The Contractor shall supply the patch cords in the quantities listed. Each patch cord is a stranded 8-pin modular plug to an 8-pin modular plug cable. The sheath and boot shall be gray in color and rated category 6A.

Length	3’	5’	7’	10’	1’4	25’
Quantity	90	150	150	100	75	25

2.04 WAP PATCH CORDS

A. The Contractor shall supply the patch cords in the quantities listed. Each patch cord is a stranded 8-pin modular plug to an 8-pin modular plug cable. The sheath and boot shall be white in color and rated category 6A

Length	1	2	3’	5’	7’
Quantity	75	50	25	35	35

2.05 VOIP PATCH CORDS

A. The Contractor shall supply the patch cords in the quantities listed. Each patch cord is a stranded 8-pin modular plug to an 8-pin modular plug cable. The sheath and boot shall be black in color and rated category 6A

Length	3’	5’	7’	10’	14’	25’
Quantity	30	30	30	15	10	5

PART 3 - EXECUTION

3.01 GENERAL

A. Deliver all patch cords in sealed cartons to Owner. Coordinate with Owner for delivery schedule and locations.

END OF SECTION 27 1619

WIRELESS ACCESS POINTS

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, specified material, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 QUALITY ASSURANCE

A. See Section 27 0513

PART 2 - PRODUCTS

2.01 WIRELESS ACCESS POINTS

A. Owner shall supply and contractor shall install Wireless Access Points (WAP).

B. Mounting brackets shall be Owner supplied as a component of the WAP

PART 3 - EXECUTION

3.01 GENERAL

A. WAPs are to be installed after the cable system has been tested and certified.

B. Contractor shall install WAPS in the locations as shown on the Drawings. WAPS are to be mounted horizontal wherein at all possible.

C. WAPS will be labeled by Owner prior to installation and Owner will provide a matrix indicating which WAP is to be placed in a corresponding location so identified in the building.

D. Contractor shall mount WAP and connect it to the category 6A plug.

E. Contractor shall validate WAP number and include on as-built drawings.

END OF SECTION 27 2133

CLASSROOM AUDIO SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This project will include design and installation of classroom A/V Systems. Components may be those currently installed, furnished by this contract or Owner Furnished, Contractor Installed as specified or as shown on Drawings.

1.02 RELATED SECTIONS

A. Section 27 0000 – Communications
B. Section 27 0500 – Common Work Results for Communications
C. Section 27 0513 – Communications Services
D. Section 27 0526 – Grounding and Bonding for Communications Systems
E. Section 27 0528 – Pathways for Communications Systems
F. Section 27 0528.29 – Hangers and Support for Communications Systems
G. Section 27 0528.33 – Conduits and Backboxes for Communications Systems
H. Section 27 0528.39 – Surface Raceways for Communications Systems
I. Section 27 0800 – Commissioning of Communications

1.03 CLASSROOM AUDIO PRODUCT CONTACT

A. Classroom audio (sound reinforcement) components shall be;
   a. LightSPEED Technologies.
   b. AMX ResQ

1.04 CLASSROOM AUDIO CABLING

A. Cables shall terminate in the classroom audio faceplate, as shown on drawings.

1.05 CABLE RACEWAYS

A. All raceway routing and mounting height information shall be coordinated with the Electrical and Architectural Drawings.

1.06 VIDEO PROJECTOR SYSTEMS

A. Classroom Projectors – Owner Furnished, Contractor Installed.
B. Classroom Projector Mounts – furnished as a part of a kit with projector
C. Classroom AV Cabling, Contractor Furnished Contractor Installed.

1.07 SYSTEM CONTROL

A. The operation shall be automated through the Owner provided classroom computer and projector remote control and shall not, typically, require adjustments or user intervention.
B. Audio Visual Playback – System shall be capable of playing DVD/PC based media, from Owner provided source equipment.

PART 2 - PRODUCTS

2.01 PROJECTOR MOUNTS AND INSTALLATION

A. Contractor is to install Owner Furnished Smart 60IW short throw projector, in locations as called out on Drawings. This is a kit and includes the mounting bracket. Part number is SB-SLR60WI.

2.02 PROJECTOR VIDEO CABLING

A. Install video cable as shown on the Drawings. Field verify final placement.

B. Contractor is to provide and install one Quiktron Rapid run cable # 42138-050 at each classroom with a projector.

C. Contractor is to provide and install one Quiktron Rapid run cable # 42404-050 at each classroom with a projector.

D. Provide one Quiktron Wallplate # 42423-001 at each classroom with a projector at locations indicated on the drawings.

E. Provide one Quiktron Wallplate # 42335-001 at each classroom with a projector at locations indicated on the drawings.

F. Provide one Quiktron Flying Lead # 42409-002 at the projector end of cable.

G. Provide one Quiktron Flying Lead # 42323-002 at the projector end of cable.

2.03 SOUND REINFORCEMENT UNITS

A. Every classroom will receive a sound reinforcement system. Units will be LightSPEED CAT 855IR, or AMX ResQ equivalent. All systems will include paging override option.

1. Systems are to be placed as per drawings. Provide ceiling mounted IR sensors at the rate of one per 1000 sq/ft or smaller classroom and at the rate of two per 1001 sq/ft or larger classroom.
2. Ceiling mount speakers are to be placed as per drawings. Lightspeed DRQ or approved.
3. Wall mount speakers are to be placed as per drawings. Lightspeed WMQ or approved.
4. Include power supply, and cables for sensor and speakers.
5. Provide, two REDMIKE volume control lanyard microphones, with batteries and charger, and Page First Option.
6. Provide stereo RCA connections between the projector and the sound reinforcement system.

2.04 USB CONNECTIONS

A. Provide USB 2.0 connectivity between the presenter location and the projector.

2.05 PATCH CORDS

A. Provide the following patch cords:

1. USB Patch Cords

Length	3’
Quantity	30

2. RCA Stereo Audio Patch Cords (Red/White connector)

Length	7’
Quantity	30

3. HDMI Patch Cords

Length	7’
Quantity	30

PART 3 - EXECUTION

3.01 GENERAL

A. A complete system shall be installed in strict accordance with manufacturer's recommendations.

B. All wiring shall be installed in raceways within walls where at all possible. Surface mounted raceway is not permitted.

C. All wiring shall be plenum rated, where routed through plenum ceiling areas.

3.02 CERTIFIED INSTALLATION CONTRACTOR REQUIREMENT

A. All new LightSPEED components must be installed by a certified contractor to preserve factory warranty.

3.03 CABLE PLACEMENT AND PATHWAYS

A. All cables must be completely enclosed (or above the dropped ceiling where applicable) except for the patch cables that transition between the Quiktron faceplate and the projector.

B. Cables may be run in the area above the dropped ceiling. In such areas, cables are to be supported by Caddy® fasteners / hangers at intervals not exceeding 48 inches. Extra slack shall not be “stored” exposed at the projector.

3.04 INSPECTION AND TEST UPON COMPLETION

A. Check-out and final connections to the Audio and video systems shall be made by a factory trained technician certified by the manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner.

B. System field wiring diagrams shall be provided to this subcontractor by the system manufacturer prior to installation.

C. Training – this contract shall provide training for not less than three District staff members. Training will include all aspects of the system as well as complete documentation covering all components requiring operator control or intervention.

3.05 SYSTEM DOCUMENTATION AND AS-BUILTS

A. Contractor shall provide a complete set of system documentation bound into a three-ring manual with a table of contents and tabs for each piece of equipment. As-built documentation shall be generated in AutoCAD® version 2010 or later and provided in hard copy as well as electronically on CD.

3.06 WARRANTY

A. All materials and installation shall be guaranteed for a minimum of one year from installation. Warranty work will be performed “on-site” at no cost to the Owner.

B. Upon completion of the installation, four (4) copies of complete operational instructions shall be furnished, complete with record drawings. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source. Final payment shall not be made until operational manuals have been received.

C. Upon completion of the installation of the equipment, the Contractor shall provide to the Owner or the Owner’s Representative a signed statement from the equipment supplier that the system has been wired, tested, and functions properly according to the specifications.

D. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The Owner or the Owner’s Representative will condemn and reject any materials or labor which are or may become detrimental to the accomplishment of the intentions of these specifications.

END OF SECTION 27 4100

INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work described by this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of a Unified Campus System in operating condition as indicated on the drawings and/or specified herein.

1. Included in the Scope of this Section:
    a) Licenses, permits as may be applicable
    b) Provision of submittal information
    c) Installation in accordance with contract documents, manufacturers' recommendations and applicable codes
    d) Configuration of control and signal processing software
    e) Testing and adjustments, including documentation thereof
    f) Provision of manuals
    g) Maintenance and warranty services
2. Applicable References:
    a) National Electric Code (NEC)
    b) Underwriters Laboratories (UL)
    c) Telecommunications Distribution Methods Manual (TDMM)

B. In general, the conduit and/or cable tray, junction boxes, electrical power circuits and outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed by the Electrical Contractor. The entire responsibility for the system, its installation, operation and function shall be that of THIS Contractor.

1.02 DESCRIPTION

A. Project Summary for consistent bidding purposes:

1. System Type: Unified Campus
2. System Mode: Intercom
3. Admin Paging: 1 Gooseneck Mic
4. Classroom / Zone Count: as per Drawings
5. Classroom Input Count and Type: (1) VGA ,(1) HDMI, (1) USB and (1) IP Video
6. Common Audio Zone Count: as per Drawings, e.g. Hallways, Outside, Offices, Cafeteria, etc.
7. Emergency Notification: Video and Audio
8. Digital Signage Displays: as per Drawings
9. Additional Admin User Interfaces
    (1) Wall Mount TP – Provide 1
    (2) iPad using TPControl app, 1 per classroom
10. Background Music Sources
    (1) Network Radio/iPod Dock, input only
11. Telephone Interface
    (1) Enhanced
12. Energy Management Options (Contact Closures)
    (a) HVAC
    (b) Lighting
13. Building Management System Interface (Contact Closures)

(a) Access Control
(b) Fire Control
(c) Security

B. This system shall consist of:
1. 1 administration control center location
2. 1 common area control centers
3. 30 classroom casework enclosures
4. 30 classroom AV switches
5. 30 classroom 27” display
6. Headend audio distribution system
7. Headend video distribution system

C. Each of these system components is described below. The audio rack shall contain the master control system in which the Integrated Audio-Video System software is to be installed. This rack location shall be dedicated to managing campus clocks, bells, PA/Intercom, remote microphones, telephone interfaces, background music sources, common zone audio and audio extractor for video sources.
1. System Includes:
a) Software
b) Admin Touch Panels
c) Bell System
d) Digital Clock Control
e) Audio Paging
f) 2-Way Intercom
g) Remote Audio
h) Teacher’s Web Interface
i) Video Broadcast (DVD, Satellite, Cable, Digital Signage, video intercom)
j) Digital Signage
k) Emergency Alerts
l) Lighting and HVAC systems interface
m) Equipment cabinet
n) Analog Telephone Paging Interface
o) Bell & Alert Tones
p) Admin Monitor Speaker
q) Loudspeakers
r) Conductors and cables.
s) All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

D. Quality Assurance

1. Installation shall be in compliance with the National Electric Code and all other applicable codes.
2. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.
3. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

E. Contractor Qualifications

1. The Unified Campus equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the Unified Campus contractor to utilize a sub-contractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
2. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
3. The Contractor shall employ factory-trained service personnel for the installation, service and maintenance of the system.
4. A statement of contractor's qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.
5. The names of at least two technicians who have or will complete factory Installation Training prior to start of project must be included with the submittals.

F. Shop Drawings

1. A complete and comprehensive list of materials with quantity, manufacturer, model and part number and reference to the Part 2 specification paragraph number for each item.
2. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.
    a) Drawings shall include designations, dimensions, operating controls, electrical requirements, input/outlet configurations, operating controls, etc.
    b) Major components including all sub-assembly components (daughter cards, option cards, etc.) required to perform the specified functions.
    c) Any items of equipment which have features and/or functions that deviate from the specifications contained herein shall have these deviations clearly called out by a separate attachment with the shop drawings specifically listing and detailing the deviation along with a justification. Deviations must be approved specifically in writing.

G. Job specific diagrams

1. This indicates a block schematic diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed.
2. Riser diagram showing conduit requirements with pull boxes, outlet boxes, part numbers of cable used, and a number of circuits in each conduit.

3. Electrical power requirements for the head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with electrical work. Electrical diagrams shall also indicate all required plug and power outlet configurations including where direct connection is required/preferred.
4. Schematic and point-to-point wiring diagrams showing all devices and wiring.
5. Identify terminals to facilitate installation, operation, and maintenance.
6. Single-line diagram showing interconnection of components.
7. Cabling diagram showing cable routing.
8. Details of interconnection with other systems
9. Supplier shall provide rack elevations showing the configuration of all rack mounted equipment including detailed interconnection diagrams between equipment
10. 30x42 floor plans at a scale of not less than 1/8"=1'-0" showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type. mounting height, etc.)
11. Proposed construction details for all custom fabricated items, including wall plates, interface panels, mounting hardware and systems, and rigging hardware. These details shall show labeling, dimensions and indicate finishes and color selection.
12. Power calculations for sizing Owner Furnished Contractor Installed UPS system.
13. Submittals that do not contain all the required information will be REJECTED unless prior approval for partial submittals has been approved.

PART 2 – PRODUCT

2.01 PRODUCT EQUIVALENCY

A. Approved Product - AMX Schoolview Unified Campus

1. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.
2. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

B. Functional Description of System

1. Bell System Functions:
   a) Software shall control and broadcast all bell tones over IP. Bell tones shall be stored as standard MP3 files and as such may be any type of audio tone, including but not limited to, bell tones, music files in part or full, recorded voice announcements, coded audio messages, or audible alerts. All MP3 files shall be directly selectable by the touch panel and web interface.
   b) MP3 files shall be stored on an easily changeable USB flash drive.
   c) The system shall support practically unlimited combinations of rooms and common areas to be saved as named zones with multiple automated schedules. Software shall provide the ability to create and maintain the bell schedules graphically on a rolling 12-month calendar.

d) Events shall be triggered by schedule or manual button on the touch panel.

e) A voice-prompted menu shall provide system administration functions via telephone. This option is referred to as “Enhanced Telephone Interface”.

2. Digital Clocks

a) Software shall control all connected digital clocks on campus. All clocks shall be RS-232 controllable and synchronized with the bell system. System time shall be capable of synchronizing to a network timeserver. The system shall provide an internal clock if network time information is not available

C. Audio Paging

1. Software shall control encoding and broadcast of live voice announcements via IP to any and all classrooms and common areas. The system shall provide practically unlimited combinations of rooms and common areas to be saved as named zones. Assignment of zones shall be chosen via a graphical floor plan image of the school. Audio paging is available from, but not limited to, the following:
2. Software shall control encoding and broadcast of live voice announcements via IP to any and all classrooms and common areas. The system shall provide practically unlimited combinations of rooms and common areas to be saved as named zones. Assignment of zones shall be chosen via a graphical floor plan image of the school. Audio paging is available from, but not limited to, the following:
3. Wall mounted microphone 1 per Admin Touch Panel
4. Push-to-talk / Remote microphones
5. Desktop telephone
6. Wireless / Cellular phone
7. Stand-alone sound system
8. Two-Way IP Intercom

a) Software shall be capable of supporting 2-way communication via the network between classrooms & predetermined locations such as a principal’s office, administration, or library.

b) The 1-way components must support a 2-way upgrade without hardware replacement. Additional encoder license and microphone may be required to deliver this functionality.

c) Events shall mute local audio sources in selected classrooms for the duration of the event and subsequently return local audio sources to the previously selected level.

D. Background Music

1. Software shall support the encoding and broadcast of Owner Furnished Equipment for MP3 or other portable audio sources to any combination of classrooms and common areas via direct IP audio streaming.
2. The Unified Campus System shall support virtually any RS-232 or IR controllable music source with published protocols including AM/FM Tuner, CD Player and / or Internet Radio.
3. The system shall provide practically unlimited combinations of rooms and common areas to be saved as named zones.
4. Events shall mute local audio sources in selected classrooms for the duration of the event and subsequently return local audio sources to the previously selected level.

F. Classroom Speaker Controls

1. Software shall provide direct network management of classroom speaker zones as a group. Individual Classroom volume control for Unified Campus is adjustable by the Unified Campus Contractor via audio decoder settings or optional external amplifier.

G. Remote Audio

1. Virtually any properly configured network data drop shall function as an input point to the system. The system shall allow the remote audio source to be defined as either a standard or priority audio event. As a standard audio event, the event shall not interrupt normal PA or bell events. As a priority event, the event shall interrupt all other audio events. Remote audio inputs shall support the following input types:
2. Microphones: The software shall support additional microphones to be connected to any network location via an audio encoding device. This device shall allow for any network jack to operate as a microphone input to the Unified Campus System.
3. Stand-Alone Sound Systems: The software shall support 2-Way audio from a stand-alone sound system such as a Gym, Lecture room, Cafeteria or Students lounge.
    a) The system shall allow for the audio from the location to be routed to any and all zones within the Unified Campus System.
    b) The system shall support local start / end of the broadcast event from the Stand-Alone Sound System. Administration location support shall not be required.
    c) The system shall also allow for the stand-alone sound system to receive any PA, bell, or background music event from the Unified Campus System.

H. Classroom Control

1. The Unified Campus System shall provide control of the following devices / features:
    a) local classroom display
    b) AV switcher/audio amplifier
    c) video decoder
2. Controls shall be available via Teacher Client. The Teacher Client shall be accessible as an application or via an Internet web browser such as Internet Explorer, Safari, Chrome and Firefox.
3. All classroom controls must communicate with the Unified Campus System.
4. Classroom display must support RS232 control with a published protocol for the following functions:
    a) Discrete Power On
    b) Discrete Power Off
    c) Discrete Input Select (VGA, Component, HDMI, Composite)
5. Specific classroom functionality shall include, but not be limited to, the following:
    a) Projector controls
    b) Room volume / mute
    c) Local source select
    d) Headend source (Campus Video) select with controls
    e) Favorite Channel
    f) Intercom control

I. Video Broadcasting
1. The software package shall direct any and all classroom and common area flat panel systems to decode IP multicast video streams generated by third party MPEG-2 or h.264 video encoders (Visionary Solutions or APPROVED substitutions). The system shall provide practically unlimited number of combinations of rooms and common areas to be configurable zones and assigned to standard video sources such as, but not limited to, the following:
a) DVD players
b) Cable converter boxes
c) Satellite receivers
2. The user shall be able to control each source from the admin touch panel, teacher's web client or graphical touch interface. Preview of the video shall be available directly on the Admin touch panel or through use of VideoLan's VLC video player on any connected PC or MAC. A video preview window shall be embedded within the teacher web client. Basic IR controls shall consist of but not be limited to navigation and transport controls.

J. Remote Video Broadcasting
1. The software package shall direct any and all classroom and common area flat panel systems to decode IP multicast video streams generated by third party MPEG-2 or h.264 video encoders, Visionary Solutions or approved substitutions.

K. Manage Displays
1. The software package shall provide network control and management of all classroom projectors. This shall include definition of auto-off times, display of lamp hours, current power status, monitoring for projector health and/or anti-theft alarms. Multiple auto-off time configurations must be available and programmable for multiple zones. The system shall support practically unlimited combinations of rooms and common areas to be saved as named zones. Named zones, groups of rooms or individual rooms shall also be controllable via a direct control interface. Control functions shall include, but not be limited to, the following:
a) Power
b) Input Select
c) Favorite Channels
d) Default Channel
e) Campus Video
f) Campus Audio

L. Digital Signage
1. The software package shall include a single (1) AMX Inspired Signage Xpress player to stream owner-created content to each display via multicast video encoder. The system shall support practically unlimited combinations of rooms and common areas to be saved as named zones. The system shall control all displays for auto-on and auto-off times. Named zones, groups of rooms or individual rooms shall also be controllable via a direct control interface, which shall include, but not be limited to, the following:
a) Power
b) Input Select
c) Channel Selection +/-
2. The system shall allow for management of crawl information of the digital signage player. The user shall be able to simply enter text using the Admin Touch Panel, either directly or via web interface.

M. Emergency Alert
1. The software package shall allow for the broadcast of audio emergency alert or drill messages to all audio zones via IP.
2. The software package shall direct any and all classroom and common area flat panel systems to decode IP multicast video streams generated by third party MPEG-2 or h.264 video encoders , Visionary Solutions or approved substitution. To be used for the broadcast of video emergency alert or drill messages.
3. The alerts/drills shall include at least Lockdown, Emergency, Fire and All Clear.
4. The system shall override current use of the projector by the teacher.
5. The system shall allow for custom messages for each alert/drill screen to be entered at the Admin Touch Panel or web interface.
6. Emergency alerts shall trigger visual, audible and textual alerts through the connected hardware.
7. On command, the system shall provide an all-clear message for one (1) minute to end the alert / drill. After the all-clear message has ended, all displays shall return to their previous state (power and input).
8. Any systems that do not return displays to their pre-alert state shall not be accepted

N. System Management
1. The software package shall provide a system management page which will consist of the following areas:
   a) System power management
   b) Default volume management
   c) MP3 Bell/Tone/Audio/Recorded voice management
   d) User access management
   e) System time management
   f) Push-to-talk (PTT) microphone zone management
   g) Direct phone paging zone management
   h) Paging chime management
   i) Classroom Status Page
   j) E-mail configuration page
   k) This item intentionally left blank
   l) Projector Alarm Management
   m) PC Management
   n) Schedule management
   o) Alert management
2. System Power
   (1) The software package shall allow certain items in the hardware racks to be powered down for the purposes of conserving electricity.
3. Default Volume
   (1) The software package shall allow these individual sources to be adjusted to a specific volume:
      (a) Push-to-talk microphones
      (b) PA microphone
      (c) Bells
      (d) Music
      (e) Phone Interfaces
      (f) Program Audio

(g) Remote Audio

b) Manage MP3 Files

(1) The software package shall allow for display of all MP3 files on the Admin touch panel graphical interface. All MP3 files shall reside on a USB flash drive in the IMS rack and adjusting the duration of each MP3 file.

c) User Access

(1) The software package shall allow for management of users and access rights to the system. A practically unlimited number of users can be added to the system with a unique password. Each user can be given access to any or all of the follow areas:

(a) Audio Events
(b) Audio Paging
(c) Video Paging
(d) Manage Displays
(e) Background Music
(f) Remote Audio
(g) Security Cameras
(h) System Management
(i) Digital Signage
(j) Emergency Alerts
(k) Energy Management
(l) Dial-in Access

d) System Time

(1) The software package shall allow for access to the Internet and network time servers for the purpose of synchronizing time-based system functions and all RS-232 clocks on campus. The system shall provide an internal clock in the event networked time information is not available.

e) Push-To-Talk (PTT) Microphone

(1) See audio paging section.

f) Direct Phone Paging (Basic)

(1) See audio paging section.

g) Alerts

(1) The software package shall provide for system alerts, which shall be audible, visual and textual. These alerts can be triggered by contact closures such as doorbell switches or motions sensors. In addition, alerts can be triggered by virtual switches tied to the interruption of network communication between the system and the classroom devices. Physical or virtual web call/panic buttons shall be available to every classroom system. Audible alerts shall be available to all PA/Intercom zones and have an assignable MP3 audio file.

(2) Visual alerts shall be available on the graphical interface via the touch panel or teacher interface. Text alerts shall be sent to any personnel assigned to receive e-mail alerts specific to the occurrence. The system shall support display of selected security camera streams on the graphical interface based on specific triggered occurrences.

h) Projector Alerts

(1) The software package shall allow for defining of a start and end time which will establish a period of time for which a trigger can be customized.

(2) The customization shall include the assigning of an MP3 tone and a zone for which the MP3 shall be played.

(3) There shall be 3 defined times which are Daytime, Nighttime and Holiday.

(4) Daytime and Nighttime hours shall be opposite of each other

(5) Holiday times shall be determined by enabling the “Switch Alerts to Holiday Mode” setting in the System Power section of the System Management page.

(6) System Response: When a display managed by the Unified Campus System is disconnected from the network or the power cord is removed. The following shall occur:

(a) Different response activities are supported for each of the Daytime/Nighttime/Holiday periods.

(b) An e-mail shall be sent to selected school personnel (or distribution list)

(c) A visual alert shall be displayed on the touch panel pinpointing the exact location of the occurrence

(d) An MP3 tone shall be played through the PA system to a designated zone setup by the user

i) Panic Button/Office Call

(1) See also Voice Reinforcement & Panic Button (optional)

j) Doorbells/ Miscellaneous Alarms

(1) Through the control processor, the Unified Campus System can receive multiple alerts from devices such as doorbells, motion sensor, door contacts, etc. The system shall allow for the defining of a start and end time which will establish a period of time for which a trigger can be customized. This trigger can be activated by a contact closure. The touch panel interface shall allow for assigning an input address to a specific named alert. The customization shall include the assigning of an MP3 tone and a zone for which the MP3 shall be played. There shall be 3 defined times which are Daytime, Nighttime and Holiday. Daytime and Nighttime hours shall be opposite of each other and Holiday times shall be determined by the setting in System Power section and by selecting the “Switching Alerts to Holiday Mode” to the active state.

(2) Scenarios and responses are identical to the projector alerts but are assigned to an individual contact closure on campus. This is to provide entry/exit alarms or chimes to the campus.

k) E-mail Notification

(1) The software package shall allow entry of e-mail addresses of individuals to receive e-mail alerts for, but not limited to, the following:

(a) Panic button alerts

(b) Projector / Display alerts

(c) Door alerts

(2) The Unified Campus System shall allow for the storage of multiple e-mails addresses of key campus or district personnel.

Addresses can be assigned to various triggered alerts for the purposes of notifying campus or district personnel. Alerts can be triggered by physical contact closures (push button), switches, or virtual web button presses.

l) Enhanced Telephone Interface

(1) The software package shall allow ability to access the system from any telephone or cell phone. The enhanced telephone interface will allow for control or access to the following:

(a) Manual bells

(b) Zoned paging system

(c) Manage Projectors

(d) Emergency alerts

(e) Telephone interface shall allow for triggering of any of the 6 manual bells that have been configured for zones and have been assigned an MP3 file. The telephone interface shall also allow for paging any of the configured paging zones and allow the phone microphone to act as the paging microphone to address any and all zones on campus. The telephone interface shall allow the user to power all projectors on or off. The telephone interface shall allow the user to trigger any emergency alerts/drills and trigger the all-clear message.

m) Classroom Software (Interface)

(1) Provide a Unified Campus System classroom control interface to allow the teacher to control the local classroom Audio/Video system. Various degrees of control shall be available depending on the type of interface provided.

(a) All Unified Campus classrooms, regardless of selected UI, shall have access to a Teacher Client and on-screen Toolbar.

(i) Must support PC users

(ii) Must support Mac users

n) Classroom Software (Functions)

(1) Provide the Unified Campus System password protected classroom software application to allow the classroom teacher to control the following:

(a) Room controls

(b) Local Source selection

(c) Video Source(s) selection and control

(d) Intercom control

o) Classroom Projector

(1) The Unified AV System graphical classroom interface shall provide basic projector controls, display streaming channel selection, room volume control and volume mute.

p) Local Sources

(1) The Unified Campus System graphical classroom interface shall provide the capability to switch the projector and audio to local classroom sources such as a classroom computer, DVD player, document camera, campus video channel, or campus background audio.

q) Video Sources

(1) The Unified Campus System graphical classroom interface shall provide for the capability to select from a list of headend sources such as DVD players, satellite receivers, cable boxes and/or DVRs to be controlled and streamed over the network. All devices shall have basic transport controls and other controls normally found on the IR remote of the device. The system shall allow for a preview window within the web client and once the appropriate media source as been selected, a “Send to Projector” function will send the desired media source directly to the classroom projector with a single button press. In the event a user in another classroom accesses this section of the user controls menu while a device is already being controlled, that source button shall appear as orange and a pop-up message shall offer the option to view without control. This is to avoid control conflicts of shared resources. Room control of shared resources shall be automatically released upon triggering the “Release Control” button or 60 minutes of no interaction. Systems not providing source control conflict notification shall not be accepted. These controls shall be available to the teacher in the classroom via the web client or 4.3-inch touch panel interface.

r) Favorite Channels

(1) When a dedicated video stream is assigned (fixed) to each desired Cable / Satellite channel, the Unified Campus System graphical classroom interface shall have the capability to have predetermined channels represented by the broadcast channel logo or icon. The user shall have the capability to preview the video embedded within the web client. Once the user has selected an appropriate video stream, the system shall have a “Send to Projector” function allowing the teacher to send the current video stream directly to the projector with a single button press.

(2) Favorite Channels are not supported when each cable / satellite tuner allows the viewer to select their desired channel.

s) Intercom

(1) The Unified Campus System graphical classroom interface shall provide for 2-way communications between the classroom and the front desk or Gym or Multipurpose room. Other functions shall include press-to-talk, place call, do not disturb, hang up call, and hands free.

(a) Up to 2 Admin Interfaces

(i) 2 Admin Touch Panel(s)

(ii) 30 iPad via TPControl license

t) Energy Management

(1) The Unified Campus System shall provide an interface to other systems, allowing administrators to exercise control of computer power management, classroom and common zone lights and HVAC functions as appropriate. Teachers have local override capability for computer power management.

(a) Classroom Computer Power Management

(i) The Unified AV System software shall allow for the management of any PC/Mac computers on the campus LAN. The software via the touch panel interface shall allow for the assigning of computers to specific rooms. Each computer shall be addressable by computer name or Mac address. The system shall provide practically unlimited combinations of rooms to be saved as named zones. Each zone can be set to a specific time to shut down all computers in that zone for the purpose of conserving energy. The system shall provide a user-friendly interface to easily change the shutdown times or temporarily override the shutdown procedure. One application for this override is for the purpose of pushing out updates to the PCs. Immediately prior to the shutdown of any computer being managed, a pop-up message will appear on the user's desktop for 60-seconds, alerting the user to the shutdown and allowing time to save documents and exit programs. The pop-up message will also provide the user the ability to delay the shutdown. When the subsequent shutdown time arrives, the same pop-up message will appear allowing for more time to be selected. If no entry is made, the computer will shut down as scheduled.

(ii) The user shall have the option to override the campus wide shutdown of classroom computers using the Touch Panel or Web client interface as provided. The available override times shall be 15, 30, 60, or 120 minutes. "Shutdown Now" shall also be provided as an option.

(b) Lights

(i) Lighting controls shall be supported

(a) AMX ClearConnect by Lutron

(b) Other systems via FieldServer Gateway

(ii) The following lighting controls shall be supported:

(a) Zone 1 ON

(b) Zone 2 ON

(c) Zones 1&2 ON

(d) All OFF

(c) HVAC

(i) When used in conjunction with the FieldServer QuickServer Gateway, the Unified Campus System software shall provide simple climate controls of the classrooms and other zones from the Admin TP as supported by the mechanical system(s).

(ii) The system shall support Selected Zone(s) On or Off

(iii) The system shall support Setpoint + and –

(iv) Control of all listed functions shall be limited to remain within the facility's energy management policy.

(v) The system shall support multiple OEM protocols:

(a) BACnet

(b) Mod bus

(c) Lonworks

(d) Metasys

(2) Systems that do not provide a floorplan-based Energy Management interface shall not be accepted.

u) Tools

(1) The graphical classroom interface shall provide a stopwatch application and countdown timer. The user shall have the capability to place a stopwatch or countdown timer pop-up on the teacher's computer desktop for the purpose of timing students or events.

(2) The software package described above shall be required to fulfill a complete Unified Campus System specification. All software modules and capabilities described here are included within the software package.

v) Voice Reinforcement

(1) The Unified Campus System supports voice reinforcement .

(2) See also section 27 4100 Classroom Audio Systems.

O. General Equipment And Material Requirements

1. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
3. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.
4. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

P. Administration Location

1. Provide a password protected interactive touch panel in the administration area of the school campus. The touch panel shall provide access to and control of the Unified Campus System software. System shall provide one wall mounted microphone and one push-to-talk microphone. There shall be a ceiling mounted speaker with an associated volume control. The software shall allow for network access and control of the administrative touch panel from anywhere on the school's LAN or district WAN.
2. Required hardware :
   a) Admin touch panel: AMX FG5968-13 MXD-1000L (Wall Mount), provide two.
   b) AMX rough-in box Model # FG039-17, provide two.
3. Required hardware for optional features:
   a) Gooseneck wall mount microphone (Shure 503BG with G12, or equivalent)
   b) Push-to-talk microphone (Shure 522 or equivalent)
   c) 8-ohm volume attenuator (DAT8ST or equivalent)
   d) 1' x 2' lay-in tile 8-ohm speaker (Lowell LT-810-BB or equivalent)

Q. Audio Rack Location

1. Provide standard rack enclosure for all equipment listed below to (typically) reside in the MDF location. Provide all shelves, rack mount kits, rack power supplies, backup power supplies, doors, rack top, lacing bars, etc. as needed to have a neatly dressed rack. The required hardware shall consist of, but not be limited to, the following:
2. Required hardware for all systems:
   a) Equipment rack: Middle Atlantic WRK-4432 (Qty. 1) plus accessories
   b) AMX NI-3100 (Qty. 1 – Primary Master)
   c) AMX NI-700 (Qty. 1 per 12 classrooms)
   d) AMX PSN6.5 power supply (Qty. as needed)
   e) AMX AC-RK rack mount kit (Qty. as needed)
   f) Barix Annuncicom 50SV (Qty. 3 – audio encoders with license)
   g) Barix Exstreamer 100 (Qty. 1 – bell player)
   h) Barix Exstreamer 100 (Qty. 1 – voice menu player for Enhanced Phone)
   i) USB flash drive (Qty. 2 – bell & voice menu MP3 file storage)
   j) Barix equipment rack mount (Qty. 1 per every 4 Barix devices in headend rack)

k) Amino H140 or AMX MA1350-85 network video decoder (Qty. 1)

l) Audio summing devices (Qty. as needed): Whirlwind PodDI

m) Applied Technical Systems CC186R rack mount clock (Qty. 1) plus power supply as needed to support clocks throughout campus

n) 70-volt amplifier (Qty. as needed to provide 1 channel per specified common area audio zone. See Drawings for additional detail.): Bogen 250 watt or equivalent

o) Network switch (Qty. as needed, Owner Furnished Contractor Installed)

3. Additional required hardware for optional features:

R. Video Rack Location

1. Provide standard rack enclosure for all equipment listed below to reside in the library or video media storage location. Provide all shelves, rack mount kits, rack power supplies, backup power supplies, doors, rack top, lacing bars, etc. as needed to have a neatly dressed rack. This location shall consist of, but not be limited to, the following:

2. Required hardware for all systems:

a) Equipment rack: Middle Atlantic WRK-4432 (Qty. 1) plus accessories

b) AMX NI-3100 (Qty. 1 – Source Master)

c) Pelco video switcher with loop thru video (Qty. 1)

d) Digital Signage

(1) Required:

(a) AMX FG1231-01 player

(b) AMX FG1231-20 Standard License

(c) AMX FG525 or FG1231-71 mounting bracket

e) MPEG-2 or h.264 video encoders

(1) 1 per video source (composite, S-Video, YPbPr, HDMI)

(2) Approved: Visionary Solutions AVN-200, AVN-441HD

f) Video sources – must be IR-controlled using codes from AMX IR Library or submit remote control for capture)

(1) DVD Player (Qty. as needed)

(2) Satellite Receiver (Qty. as needed)

(3) DVR (Qty. 1 as needed)

(4) Others as approved

g) 19” rack mounted preview monitor (LCD) with composite video input and integrated speakers

(1) Approved: Tatung TM17

h) Audio summing / Attenuation devices (Qty. 1 per source as needed)

(1) Approved: Whirlwind PodDI

i) Network switch (Qty. as needed, possibly provided by others; see separate network specifications): Recommended Cisco Catalyst series

S. Common Areas Audio (Hallways)

1. Provide 70-volt speakers, which will interface to the 70-volt amplifier listed under audio rack location. Audio zones shall be established as per the Drawings. Each zone shall consist of 70-volt speakers and be tapped at the wattage desired to provide the best sound for each speaker location without overloading the speaker or amplifier.

a) Acceptable: 2’ x 2’ 70 volt lay-in tile speaker (Lowell LT-810-72-BB or equal)

2. Common Areas Audio (Offices)
    a) Allow for offices requiring 1-way communication, reception of bells and PA announcements by connecting to the closest 70-volt zone.
        (1) Acceptable: 1’ x 2’ 70 volt lay-in tile speaker (Lowell LT-810-72-BB or equal)
        (2) Acceptable: 70-volt wall volume attenuator as needed
3. Common Areas Audio (Outside)
    a) Provide 70-volt weatherized speakers to cover the desired area outside of the building(s) of the campus.
        (1) Acceptable: 70-volt horn speaker
        (2) 70-volt weatherized speaker

T. Remote Audio Locations:
1. Provide integration of new stand-alone sound systems such as the following:
    a) Gym sound systems
    b) Cafeteria sound systems
    c) Required: Barix Annuncicom 100SV (Qty. 1 per stand-alone system)
2. Control volume levels and source selection for the gym and multipurpose sound systems.
    a) See drawings for Control Panel locations.
    b) Configure the controls to provide audio source and output signals to each individual room or as a larger combined space. Refer to sound system drawings and specifications.
    c) Configure the controls to provide video source and output signals to each individual room or as a larger combined space.

U. Common Areas Clocks
1. Provide a digital clock system, which will interface to the Unified Campus System. Clock subsystem shall be RS-232 controllable. Each clock shall be daisy chained to the next, and back to the audio rack location. Provide quantities and styles as needed.
    a) Acceptable: ATS CC2002 single sided wall clock
    b) Acceptable: ATS WG2091 guard for gym (clock not included)
    c) Qty as shown on drawings

V. Classroom Hardware Configurations
1. Unified Campus classrooms are fully featured classrooms with integration of local A/V sources, head end based and remote audio sources (bells, PA, background music, push-to-talk microphones, gym & cafeteria audio systems, etc.) and head end based and remote video sources (DVD players, TV tuners, broadcast cart, emergency alerts, etc.)
2. SchoolView Unified Campus options shall include the following hardware:
    a) SchoolView Equipment Tray for ceiling enclosure or surface mount
    b) Audio Decoder (Barix Annuncicom 50SV)
    c) Microphone for Intercom
    d) Push-to-Talk or Call Button
    e) Video Decoder (Amino H140)
    f) AMX AVX-400 CAT5 presentation AV switcher with audio amplifier
    g) AMX UPX-CN+A-US
    h) System cabling (minimum of one of each shown below or as shown on Drawings)

(1) 2' CAT5 network patch cable
(2) 2' RCA to captive screw audio cable
(3) 2' DB9 Female to captive screw RS-232 cable
(4) VGA cables
(5) HDMI cable
(6) RS-232 cable with appropriate connectors based on display
(7) 2 conductor speaker cable (length as needed)

i) Teacher Client plus interfaces:
(1) AMX SP-08 8 button keypad (1 per room)

3. 1’ x 2’ 8 ohm lay-in tile speaker (Lowell LT-805-BB or equivalent) Qty. as needed to cover classroom. Additional amplification as necessary.
4. The Unified Campus classroom includes the teacher interface and toolbar PC/Mac based interfaces. Classroom control features vary with interface, but shall include these as MINIMUM REQUIREMENT:
   a) Display Power Control
   b) Input Select
   c) Volume Up / Down
   d) Mute
   e) Push-to-Talk (for Intercom)
   f) Channel Up / Down
5. Classroom Display
   a) Flat panel or projector
   b) Must support RS232 control, using a published protocol
   c) Network control shall be delivered via Audio Decoder’s Ethernet bridge function

W. Classroom Input Options:
1. Campus Video
2. Additional UPX-xx input plates
   a) VGA: UPX-RGB+A-DE-W (1 per room)
   b) HDMI: UPX-HDMI+A-DE-W (1 per room)

X. Classroom Installation
1. With SchoolView Casework Placement
   a) IP addresses shall be assigned and projector drivers shall be loaded offsite. Once the facility is secure and classroom construction is complete, the classroom equipment mounted to the slotted tray shall be installed to the casework on-site.

Y. NetLinx Masters
1. NI8100 with Primary Master software
   a) 1 per system
   b) This item shall provide Primary controls and communications for the Unified Campus system.
2. NI3100 with Source Master software
   a) 1 per system
   b) Located in Video Rack
   c) This item shall provide IR controls of Campus Video sources (8 max)
   d) Additional control devices may be added for 9+ controlled devices

3. NI700 with Room Master software
   a) Classrooms / Zones shall be assigned to a zone master for distributed processing and management. Physical location and network topology to be determined during project design phase in conjunction with the site's network design team. Provide 4.
4. NI700 with Flat Panel Software (FPS)

Z. Battery Backup Power Unit
1. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
2. Unit shall supply public address equipment with appropriate power automatically during an outage of normal 120-V ac power.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

A. Equipment shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all local, city, state and national codes.
1. Provide all hardware, framing members, etc. as required for mounting supports.
2. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.
3. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.
   a) It is the Contractors responsibility to coordinate necessary configuration details of the data network equipment (by others), such as:
      (1) Configuration of IGMP snooping on all data switches which will receive IP multicast traffic, to prevent flooding of traffic to ports which do not need it
      (2) Configuration of at least one IGMP querier on the network
      (3) Allocation of reserved, static IP addresses for all system equipment
      (4) Creation of port-based VLAN(s) for all system equipment, without DHCP service
      (5) Assignment of all dedicated ports to the VLAN described above.
4. Conductors And Cables
   a) Jacketed, twisted pair and twisted multipair, untinned solid copper.
   b) Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
   c) Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   d) Plenum Cable: Listed and labeled for plenum installation.
5. Raceways
   a) Conduit and Boxes: Comply with Section 27 0528.33 - Raceway and Boxes for Communications Systems

b) Outlet boxes shall be not less than 2 inches wide, 3 inches high and 2-1/2 inches deep.

6. Wiring Methods

a) Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

b) Install plenum cable in environmental air spaces, including plenum ceilings.

c) Comply with requirements for raceways and boxes

d) Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

e) Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

7. Installation Of Raceways

a) Comply with requirements in Section Raceway and Boxes for Electrical Systems for installation of conduits and wireways.

b) Install manufactured conduit sweeps and long-radius elbows whenever possible.

8. Installation of Cables

a) Comply with NECA 1.

b) General Cable Installation Requirements:

(1) Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

(2) Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

(3) Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

(4) Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

(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. Heat lamps shall not be used.

(7) Open-Cable Installation:

(a) Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

(b) Suspend speaker cable not in a wire way or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.

(c) Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

9. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.02 PROGRAMMING / CONFIGURATION

A. It is the Contractors responsibility to configure the system in this section according to the Owner's wishes. This includes the set up and assignment of channels, coordination of services, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the configuration. This agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final configuration.

B. It is the Contractors responsibility to coordinate all IP multicast addresses and port numbers to be used with the Owner and/or Engineer to ensure that they are acceptable, available and unrestricted on the Owners network. This information must be provided in order to create configuration files for the project.

3.03 TESTS

A. Upon completion of installation and satisfactory testing of system by Contractor, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; Submit report indicating result to the Engineer.

3.04 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both end and at each point where the cable is administered.

B. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.05 TRAINING

A. Provide step-by-step user instructions identifying operator controls for normal use operations. This shall be included with the O&M manuals.

B. The contractor shall arrange for a total of sixteen (16) hours for end user training on the various A/V Systems. This training shall be planned and scheduled with the Owner. Training plan shall be pre-approved by the Engineer/Architect and shall include a review of the proposed syllabus.

3.06 OPERATION AND MAINTENANCE MANUALS

A. Copies of all approved shop drawings with the Engineer's stamp.

B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

G. Provide statement of warranty with O&M Manuals.

3.07 WARRANTY

A. This Contractor shall warrant all workmanship, equipment and material provided under this contract for a period of one (1) year from the date of approval of certificate of contract completion by the Owner. Provide statement of warranty with O&M Manuals.

B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

C. Where warranties on individual pieces of equipment exceed twelve months, the guarantee period shall be extended to the warranty period of the particular items.

D. After completion of the work, the Contractor shall submit a Certificate of Warranty, stating commence and expiration dates and conditions of the warranty, for signature of both participating parties. Incremental warranties for complete portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor.

END OF SECTION 27 4116

PAGING SYSTEMS

PART - 1 - GENERAL

1.01 SUMMARY OF WORK

A. It is the intent of this Section in conjunction with the applicable Drawings is to provide specifications for a complete and functional system. All locations, as detailed on the Drawings, shall be tested and balanced as to provide a reasonable level of volume to accommodate the paging needs of the school. This includes classrooms, administrative and general areas as well as the Commons, Gymnasium and, where specified, exterior areas of the building.

1.02 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment for a complete and operational overhead paging system as called for in the specifications and Drawings, specifically:

1. Public address system amplifiers, zone controls, back boxes, and all equipment, cabling and support required to interface the Public Address System to the Owner's Telephone System (Not included in this contract).
2. Public Address System Speakers, ceiling mounted, wall mounted horn, both interior and exterior.
3. Volume attenuators where shown on the drawings to adjust the PA speaker sound level.
4. PA override signal to local sound systems. Coordinate with 27 4116 contractor.
5. Messaging calendar clock capable of receiving and scrolling up to 64 character custom messages without affecting or replacing display of time segments.
6. Interactive Graphical User Interface (IGUI) to intercom functions including zone or all page, answering intercom call-ins, selecting and distributing program sources to predefined zones or all zones and facilitating single action activation of multiple system interface e.g. access control and CCTV or other systems as directed by Owner.

1.03 QUALITY ASSURANCE

A. See Section 27 0513

B. The Contractor shall currently maintain a locally run business for a minimum of five years and shall be an authorized distributor of the supplied equipment with full warranty privileges.

C. The Contractor shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the equipment manufacturer to maintain and service the equipment being supplied.

D. Contractor shall have attended the manufacturer's installation and service school.

E. The Contractor shall furnish manufacturer's manuals of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper operation of the system must be included. Any bidder using other than the specified equipment must provide this information prior to bidding.

F. As built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied both electronically in AutoCAD® 2010 (or later) and as a full size (30" x 42") drawing upon completion of project.

1.04 IN SERVICE TRAINING

A. The Contractor shall furnish a minimum of four hours of in service training with the system. These sessions shall be broken into segments that will facilitate the training of individuals in operating station equipment, administrative devices, user programming functions, and program distribution equipment. Operating manuals and users guides shall be provided at the time of the training.

1.05 MAINTENANCE SERVICE

A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner or engineer.

B. A maintenance contract offering continued factory authorized service of this system shall be made available if requested by the Owner.

1.06 SUBMITTALS

A. Data sheets shall be provided on all equipment being provided.

B. Internal control cabinet drawings showing internal block diagram connections shall be provided.

C. Wiring diagrams, detailing wiring for power, signal, and control, differentiating clearly between manufacturers installed wiring and field installed wiring. Identify terminals to facilitate installation, operation and maintenance.

D. Provide a riser diagram for the system showing in technically accurate detail all connections, interconnections, and all provisions available and made for adaptability of all specified future functions and including all calculations, charts, and test data necessary to demonstrate that all systems and system components deliver the specified signals, grades, and levels at all required points and locations.

1.07 REGULATORY REQUIREMENTS

A. The entire installation shall comply with all applicable and safety codes. All central equipment and additional applicable equipment shall be listed by Underwriters' Laboratories, per US requirements. Note: Furnish an original, dated specimen of the test agency's listing card with the submittal.

B. All equipment with digital apparatus (microprocessors) that generate and use timing signals at a rate in excess of 9,000 pulses per second to compute and operate must be Federal Communications Commission (FCC) and DOC CSA standards C108.8 (Electromagnetic Emissions) compliant. Any non-compliant equipment supplied or installed shall not be accepted and shall nullify the contract. Note: Provide documents supporting and verifying compliance.

C. Systems shall be considered non-compliant unless they completely meet the criteria as outlined in this section. All supporting documentation shall be included as part of the initial submittal package. Letters regarding "future approval" or "approval pending" shall not be considered.

PART - 2 PRODUCTS

2.01 GENERAL

A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture. Equipment and material shall carry Underwriters Laboratory certification if required by local, state or national codes.

B. Refer to Section 274116 for additional paging / intercom requirements.

C. The installation shall include a comprehensive programmable microprocessor based communications system consisting of a central switching exchange capable of handling up to 32 paging zone groups each capable of 99 zones.

D. The Paging System Controller is to interface with AMX schoolview in a manner that allows any telephone handset to be used as a microphone for access to the paging system upon entering the proper access code for the paging system. All components necessary to interface the paging system to the VoIP phone system shall be the responsibility of this contract.

E. Interface with clock system for time synchronization.

F. The central switch shall utilize standard dual tone multi-frequency type decoding (DTMF) for conformance with standard telephone practices.

G. Provide an amplifier circuit for each of the paging zones. Provide separate paging zones as shown on drawings.

H. Provide eight (8) separate time-tone schedules with a minimum of 1024 events. Individual events of each schedule shall be capable of sounding one of nine user defined tone types. These schedules can be run individually or simultaneously.

I. Provide eight (8) internal relays which can be activated manually from any administrative phone or automatically via an optional integral Master Time Control Center.

J. Program distribution of audio program sources to any one or group of paging zones.

K. System shall be capable of nine (9) built in software definable signaling tones.

L. Two (2), three (3) or four (4) digit programmable zone numbers for paging zones.

M. Integral internal program clock for time tone distribution and other time related functions. It shall be possible to synchronize the program clock from an external master clock.

N. Pre-announce tones will alert the listeners of incoming calls with distinct tones for each priority level. To prevent unauthorized monitoring, the tone will sound whenever an area is being monitored, and will repeat at regular intervals. Facilities shall also be provided to defeat the tone repeat function from the console if it is not desired.

O. Emergency and All Call paging and a minimum of 32 zones of group paging - The paging zones shall be independent of the time tone and audio program distribution zones and a minimum of 8 clock messaging zone. Systems sharing zones for both paging and tone shall not be acceptable.

P. As per NEMA SB-40, Call-in device in the classroom will be in the form of a call switch and shall include a privacy option. The system shall be capable of call-switch supervision as well as the ability to install multiple, supervised call-switches in a single room. Multiple call switch installation shall allow for each switch to be programmed to call separate console locations and have separate priorities. Systems that require additional cabling for this feature shall not be accepted.

Q. The paging speaker shall be 8" with integral transformer assembly. Provide with metal baffles and enclosures

R. Gym and Commons area speakers to be equipped with vandal resistant baffle.

S. Weatherproof outside paging loudspeakers shall have a minimum power rating of five (5) watts. The speaker shall have a minimum frequency response of 80-10KHz and a dispersion angle of 120 x 60 degrees.

T. It shall be possible to distribute paging, time tone class change, or emergency signal to all rooms or specific groups of rooms as programmed into the system software.

U. Program sources for distribution shall be:

1. An Owner provided MP3 player.
2. Provide a Music input along with the emergency microphone located in the Main office.

V. All programmable functions shall be located in battery backed ram to prevent loss in a power failure condition

2.02 PRE-APPROVED PART

A. AMX SchoolView system shall be accepted for both paging and wireless master clock system (Section 27 5313) as a complete package.

2.03 LAN/WAN CONNECTIVITY

A. Controller access and operation shall be one hundred percent compatible with IEEE 802.3 Ethernet and be equipped a LAN port for offsite programming and diagnostics.

B. System must have the capability to add optional remote stations/ power supplies with LAN connectivity to main controller.

PART - 3 EXECUTION

3.01 INSTALLATION

A. Complete system shall be installed in strict accordance with manufacturer's recommendations.

B. All wiring shall be installed in raceways or plenum rated, where routed through plenum ceiling areas.

C. All cable shall be as per manufacturer specification.

3.02 DISTRICT COORDINATION

A. Contractor shall be responsible for coordination of all IP address requirements with District.

B. Contractor shall coordinate all routing and firewall requirements and verify proper operation with District IT staff.

3.03 INSPECTION AND TEST UPON COMPLETION

A. Check-out and final connections to the system shall be made by a factory trained technician in the employ of a manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner. At a minimum, the following must be demonstrated:

1. Paging of each zone to verify volume and clarity of message
2. Synchronization of clocks, bells and paging to same (exact) time.
3. Paging from telephone handsets from any location within the school.
4. Ability to program multiple, different schedules for bells to heard throughout he buildings speakers and horns.
5. Remote access capability

B. System field wiring diagrams shall be provided to this subcontractor by the system manufacturer prior to installation.

C. All materials and installation shall be guaranteed to be free of defects in material and workmanship for one year after final acceptance of installation and test.

D. As-built drawings: 3 sets. They should include up-to-date drawings that include any changes made to the system during installation. Circuit diagrams and other information necessary for the proper operation and maintenance of the system shall be included. Drawings must be provided on CD in AutoCAD® 2010 format.

E. Upon completion of the installation, four (4) copies of complete operational instructions shall be furnished, complete with record drawings. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source. Final payment shall not be made until operational manuals have been received.

F. Upon completion of the installation of the equipment, the Contractor shall provide to the Owner or the Owner’s Representative a signed statement from the equipment supplier that the system has been wired, tested, and functions properly according to the specifications.

G. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The Owner or the Owner's Representative will condemn and reject any materials or labor which are or may become detrimental to the accomplishment of the intentions of these specifications.

END OF SECTION 27 5113

CLOCK SYSTEMS

PART - 1 - GENERAL

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

1.02 WORK INCLUDED

A. Master Clock / Transmission System
   1. Primary Encoder with GPS. Receiver
   2. Primary Internal Transmitter
   3. Primary External Transmitter

B. Wireless Synchronized Devices
   1. Analog Clock
   2. Digital Clock
   3. Alphanumeric Data Display

1.03 RELATED SECTIONS

A. Section 27 0500 - Communications

B. Section 27 5113 – Paging System

1.04 QUALITY ASSURANCE

A. See Section 27 0513

B. All clocks and associated equipment shall be installed in a neat and workmanlike manner.

C. All secondary clocks will be tested and certified for synchronization and Daylight Savings Time adjustment.

1.05 DEFINITIONS

A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

1.06 SYSTEM DESCRIPTION

A. GPS synchronized wireless time system shall continually synchronize clocks, data display units and PA speakers time throughout the facility and wireless PA voice messaging where needed.

B. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time to all its components. The system shall not require any hard wiring (beside AC power) for all its components. Analog clocks shall be battery operated. Clocks shall automatically adjust for Daylight Savings Time.

C. The system shall provide a text messaging to a specific or group of Alphanumeric Data Display units.

D. Analog Clocks shall be synchronized within 2 milliseconds up to 6 times per day, and each clock shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that overall clock accuracy shall not exceed plus or minus 0.05 seconds.

E. The system shall include an internal real time clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating the right time.

F. The system shall provide an 802.3 Ethernet based network interface to enable system remote programming and maintenance.

G. The system shall incorporate a “fail-proof” design so that a temporary power interruption shall not cause failure of the all system. Upon restoration of power, the system shall resume normal operation without the need to reset the system or any of its components.

H. The system shall include a test pager, to notify maintenance personnel of any system malfunction.

1.07 REGULATORY REQUIREMENTS

A. Equipment and components furnished shall be of manufacturer’s latest model.

B. Encoder, Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:

1. This device may not cause harmful interference, and
2. This device must accept interference received, including interference that may cause undesired operation.
3. Transmitter frequency shall be governed by FCC Part 90.35.
4. Transmitter output power shall be governed by FCC Parts 90 and 74.

C. System shall be installed in compliance with local and state authorities having jurisdiction.

1.08 SUBMITTALS

A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.

B. Operating License: If license is required, submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed at the location directed.

D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

1.09 SUBSTITUTIONS

A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.

B. Proposed substitutions shall be identified not less than 10 days prior to bid date.

C. Other systems requiring wiring and/or conduit between master and clocks will not be acceptable.

1.10 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing commercial wireless systems with a documented experience of minimum of 10 continuous years.
2. Installer: Company with documented experience in installation of commercial wireless systems.

1.11 DELIVERY STORAGE AND HANDLING

A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.

B. Store equipment in finished building, unopened containers until ready for installation.

1.12 PROJECT SITE CONDITIONS

A. Clocks shall not be installed until painting and other finish work in each room is complete.

B. Coordinate installation of GPS receiver and external antenna (if used) for access to the roof or exterior side-wall so that the bracket and related fasteners are watertight.

PART - 2 PRODUCTS

2.01 MANUFACTURER

A. GPS synchronized wireless time, voice and data system and its components shall be manufactured by Sapling, Inc, 1633 Republic Road Huntingdon Valley, PA 19006, (215).322.6063 , or approved alternate. Where Sapling parts are called out, appropriate AMX wireless products are acceptable and considered equal.

B. AMX SchoolView shall be accepted as equal substitution for both wireless master clock and paging system (Section 27 5113) as a complete package.

2.02 CLOCK CONTROLLER

A. The Master Clock / Transmitter shall be the Sapling SAM 3000 or approved alternate. The transmitter shall be:

1. Capable of transmitting data to wireless analog clock and wireless digital clock
2. Capable of receiving a signal from an atomic clock web site via the Internet
3. Controlled via the web

B. Additionally, the master clock shall have software that allows it to:

1. Act as a (S)NTP Server
2. Activate a countdown feature on digital clock models

C. The transmitter shall have a programmable auxiliary relay and shall be programmed anywhere from 1—99 seconds. Upon utilization of the relay, the transmitter will be capable of interfacing with a once a day closure or interfacing with intercom systems.

D. The transmitter shall be capable of acting as a repeater while receiving a signal wired or wirelessly from the main transmitter.

E. Web Interface – The master clock shall be able to be programmed completely from a web interface that can be accessed through any typical web browser such as Microsoft Internet Explorer or Mozilla Firefox. The interface shall allow the user to program all bell schedules, events, display features, IP settings of the master clock and any system setting that the master clock has.

F. The transmitter shall be capable of transmitting data to the SAL wireless analog clock and the SBL wireless digital clock. The master clock shall be capable of receiving a signal from any SNTP time server via the Internet. The transmitter shall utilize 915–928 MHz frequency–hopping technology. The master clock shall be capable of acting as a repeater while receiving a signal wired or wirelessly from the main master clock. The transmitter shall be FCC compliant, part 15 Section 15,247.

2.03 WIRELESS REPEATER

A. Wireless repeater shall be Sapling SMA 1000.

2.04 ANALOG CLOCK

A. The secondary clock shall be a Sapling SAL Series wireless clock or approved alternate. The clock will be capable of receiving a signal from multiple clocks. The clock shall receive and transmit with 915–928 MHz frequency–hopping technology.

B. The clock is to be capable of transmitting the time simultaneously without interfering with each other. The clocks shall include automatic calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, a gearbox test and a comprehensive analysis of the entire clock.

C. The clock shall have a maximum correction time of five (5) minutes. It shall be designed to be used with the Sapling Transceiver or the Sapling Repeater, which can be regulated via Sapling wireless communication protocol. Upon receipt of the wireless signal, the clock will immediately self–correct.

D. The clock shall have a semi–flush smooth surface ABS case. The dial is to be made of durable polystyrene material. The crystal is to be shatterproof, side molded polycarbonate. Glass and visible molding marks are unacceptable.

E. The classroom and administrative area clocks shall be 12 inches in diameter (minimum), have black hour and minute hands.

F. The Gymnasium clocks shall be 16 inches in diameter (minimum), have black hour and minute hands. Gymnasium clocks shall be protected by a cage specifically designed for such purpose that does not interfere with the readability of the clock.

2.05 DIGITAL CLOCK

A. The digital clocks shall be capable of working in one (1) of the following options:

1. 110 volts AC; the clock receives and transmits time every one (1) minute.
2. 24 volts AC/DC; the clock receives and transmits time every one (1) minute.

B. The elapsed timer shall be capable of working in conjunction with either the four (4) digit or six (6) digit digital clocks and shall have the ability to count down or count up.

PART - 3 EXECUTION

3.01 INSTALLATION

A. Provide Clocks in all rooms as adjacent to paging speakers. Final placement may be field determined. Coordinate with Architect elevations.

B. Clock headend equipment shall be installed in Main Equipment Room.

C. Wireless repeater shall be located in the Telecommunications Room (TR).

3.02 START-UP

A. Synchronize secondary clocks with master clock and Intercom System.

B. Cycle through Daylight Savings Time and verify correct time change on all clocks. Document results and include in as-built documentation.

3.03 TRAINING

A. Provide system training to Owner which addresses all phases of operation including:

1. System programming from local PC using a networked connection from the Main Office
2. Remote access methodology
3. Build standard daily schedule for purposes of test and verification of operation.

B. Provide two follow-up sessions of one hour each as requested by the Owner. These sessions shall be within 60 days of system acceptance.

END OF SECTION 27 5313

DISTRIBUTED ANTENNA SYSTEM (DAS)

PART 1 – GENERAL

1.01 SUMMARY

A. This specification describes the technical and performance criteria for deploying a Neutral-Host Basic Distributed Antenna System (DAS) capable of supporting Public Safety Networks (PSN) and subsequent enhancement to support Wireless Service Providers (WSP) for Cellular Telephones and/or District specific - Radio System.

1.02 RELATED DOCUMENTS

A. Comply with the referenced codes and standards, guidelines and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

1. Codes
    a. Federal Communications Commission (FCC)
    b. National Electric Code® (*NEC*®)
    c. National Electrical Safety Code (NESC)
    d. National Fire Protection Association (NFPA)
    e. Occupational Safety and Health Administration (OSHA)
2. Standards:
    a. American National Standards Institute (ANSI)
    b. National Electrical manufacturers Association (NEMA)
    c. Telecommunications Industries Association (TIA)
    d. Electronic Industries Association (EIA)
    e. Institute of Electrical and Electronics Engineers (IEEE)
    f. Underwriters Laboratories (UL®)
    g. American Standards Association (ASA)
3. Eugene Springfield Fire Marshal Technical Advisory No. 14-01, February 24, 2014

B. The following guidelines:

1. BICSI, Telecommunications Distribution Methods Manual (TDMM)

C. Drawings and general provisions of the Contract, including General and Supplemental Conditions and other Division 1 Specification Sections, apply to this Section.

1.03 RELATED SECTIONS

A. Section 26 3200 – Packaged Generator Assemblies
B. Section 26 3353 – Static Uninterruptable Power Supply
C. Section 27 0005 – Common Work Results for Communications
D. Section 27 0513 – Communications Services
E. Section 27 0526 – Grounding and Bonding for Communications Systems
F. Section 27 0528 – Pathways for Communications Systems
A. Section 27 0528.29 - Hangers and Supports for Communications Systems
B. Section 27 0528.33 - Conduits and Backboxes for Communications Systems
C. Section 27 0528.36 - Cable Trays for Communications Systems
D. Section 27 0528.39 - Surface Raceways for Communications Systems

1.04 SECTION INCLUDES

A. This specification describes technical and performance criteria for deploying a Neutral-Host Distributed Antenna System (DAS) capable of supporting emergency responder / Public Safety Networks. The DAS components specified in this document include:

1. Donor Antennas,
2. Coverage Antennas,
3. Coax Cable,
4. Coax Connectors,
5. Splitters,
6. Combiners,
7. Couplers,
8. Fiber-Optic Cable,
9. Fiber-Optic Connectors, and Fiber-Optic Jumpers,
10. Bi-Directional Amplifiers (BDA),
11. Fiber-Optic Master Unit and,
12. Fiber-Optic Remote Units

1.05 SYSTEM DESCRIPTION

A. This is a performance based specification section. It is the Contractor's responsibility to satisfy the requirements of the AHJ in terms of repeating emergency response signals.

B. Upon commissioning, the DAS shall provide coverage for the PSNs listed below on all frequencies currently being used by the designated PSN.

Service	MHz
VHF	153 - 159
UHF	450 - 512

C. Passive DAS Infrastructure, the DAS shall have expansion capabilities to support the following PSN. Any additional Components required for system expansion shall comply with all specifications of this Section.

D. PSN Approval: The Contractor shall propose and deploy a DAS system capable of receiving approval of the PSN Authority Having Jurisdiction (AHJ).

E. Broadband Active Distribution: If active distribution is required due to size of building, single-mode fiber-optic cable will be used. In-line amplifiers are not allowed.

F. Network Management:

1. NMS: The DAS shall have a Network Management System (NMS) capable of alarm, monitor, configuration and control of all Active Components including, but not limited to:
   a. Door alarm for all cabinets and enclosures
   b. Temperature outside pre-set parameters
   c. Donor Antenna signal malfunction
   d. Signal booster malfunction
   e. Loss of AC power
   f. Status of uninterruptable power system (UPS) to include:
      1) Load, expressed in current draw and a percentage of total capacity
      2) Battery voltage
      3) Run-time history of all events
   g. Report to central station
2. SNMP Integration: The DAS NMS shall be capable of integration with 3rd party SNMP based NMS products for alarm purposes and provide alarming information.

1.06 ALTERNATIVES

A. No alternative component(s) shall be accepted as equal to the components and manufacturers specified in this document unless the Contractor proves that the alternative component(s) are of equal or superior specifications and quality, and that they have been used in similar projects of size and complexity for no less than 3-years. The following information shall be required for each alternative component with submittal of the bid response:

1. Passive Components:
    a. Product samples
    b. Detailed product specifications
    c. Independent test results verifying the product specifications
    d. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall remain available for new purchase for a period of 2 years from the date of system acceptance.
2. Active Components:
    a. Hardware and software manuals
    b. Detailed product specifications
    c. Mean Time Between Failure (MTBF) data for each Active Component
    d. Independent test results verifying the product specifications
    e. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall be supported for a period of 2 years from the date of system acceptance.
    f. For Active Components serving the PSN, written documentation from the AHJ that the alternative component(s) are approved for use within the PSN and that system acceptance of the DAS to the PSN will not be withheld due to the alternative component being used in the DAS.

1.07 CODES, STANDARDS AND CERTIFICATIONS

A. All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractors Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the contractor shall satisfy the most stringent requirements.

B. Requirements set forth by first-responder code, ordinance, or the PSN AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor’s responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN AHJ.

1.08 LICENSING AND PERMITS

A. Contractor shall assume all up-front permit and licensing costs associated with this system. In that components of this system operate in licensed and regulated radio frequencies, the AHJs (local, State and federal) may require a licensing agreement to be completed by the Contractor on behalf of the Owner detailing the system, components and installed (or potentially available) frequencies on which this system will operate.

1.09 ABBREVIATIONS AND ACRONYMS

A. ACG: Automatic Gain Control
B. AHJ: Authority Having Jurisdiction
C. ATP: Acceptance Test Plan
D. AWS: Advanced Wireless Service
E. BDA: Bi-Direction Amplifier
F. BOM: Bill-of-Material
G. BRS: Broadband Radio Service
H. BTS: Base Transceiver Station
I. CDMA: Code Division Multiple Access
J. C/N: Carrier-to-Noise Ratio
K. CWDM: Coarse Wave Division Multiplexing
L. DAS: Distributed Antenna System
M. DWDM: Dense Wave Division Multiplexing
N. EBS: Educational Broadband Service
O. ESMR: Enhanced Specialized Mobile Radio
P. FCC: Federal Communications Commission
Q. GUI: Graphical User Interface
R. LMR: Land Mobile Radio
S. LTE: Long Term Evolution
T. MTBF: Mean Time Between Failure
U. NFPA: National Fire Protection Association
V. NMS: Network Management System
W. PCS: Personal Communications System
X. PSN: Public Safety Network
Y. RoF: Radio-over-Fiber
Z. RoHS: Restriction of Hazardous Substances
AA. RSL: Received Signal Level CC.
BB. SMR: Specialized Mobile Radio
CC. SISO: Single-Input, Single-Output
DD. SMS: Short Message Service
EE. SNIR: Signal-to-Noise Interference Ratio
FF. SNMP: Simple Network Management Protocol
GG. SOW: Statement of Work
HH. VSWR: Voltage Standing Wave Ratio

1.10 DEFINITIONS

A. Acceptance: Expressed approval by the customer
B. Active: DAS components that require AC/DC power for operation
C. Carrier Approval: Expressed approval to interconnect to the WSP macro network
D. Channel: A path for an RF transmission between two points. Reference Eugene Springfield Fire Marshal Technical Advisory No. 14-01, February 24, 2014 for frequency requirements.
E. Component: A main system element of the DAS
F. Contractor: The prime contractor bidding the project
G. Passive: DAS components that do not require AC/DC power for operation

1.11 PERFORMANCE REQUIREMENTS

A. PSN DAS:

1. The PSN DAS shall comply with NFPA-1 2012 Edition.
2. Contractors shall state the assumed channel count for the PSN Frequency Bands identified above in Section 1.05 A. with submittal of bid response. Prior to installation, contractors shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.
3. The DAS shall be capable of upgrade, without additional hardware or software, to allow for changes to system frequencies within the deployed frequency band in order to maintain radio system coverage as originally designed.
4. The contractor shall explain the method used to avoid downlink and uplink interference.

1.12 ADDITIONAL REQUIREMENTS

A. PSN Approval: When approval of the DAS deployment is required by code or ordinance, the Contractor shall be responsible for facilitating the AHJ approval(s) per the requirements of the code or ordinance.

1.13 SUBMITTALS

A. Submittal Requirements with Bid Response:

1. Certificates:
   a. Manufacturer's certification attesting that bidder is fully trained and certified on the proposed DAS equipment.
2. Product Data: Submit manufacturer datasheets for the following components:
   a. Donor and Coverage Antennas
   b. Coaxial Cable and Connectors
   c. Splitters, Combiners and Couplers
   d. Bi-Directional Amplifiers (BDA) / Repeater
   e. Fiber-Optic Master Unit
   f. Fiber-Optic Remote Units
3. Shop Drawings: Submit the following items:
   a. RF link budget
   b. Overlay of system Components on floor plans
   c. Drawings for Donor Antenna and grounding
   d. Bill-of-Material (BOM)
4. Statement of Work (SOW): Submit sample SOW
5. Acceptance Test Plan (ATP): Submit sample ATP
6. Recommended Spares
7. Warranty Documents:
   a. Submit for all manufactured Components specified in this Section.
   b. Submit Contractor's System Warranty.
   c. Submit Manufacturer's Extended Warranty.

B. Submittal Requirements Prior to Start of Construction

1. Construction Drawings approved by AHJ (based on bid set drawings) for final configuration and installation. Drawing to be stamped by Electrical Engineer licensed to practice in the State of Oregon.
2. Final RF link budget
3. Overlay of system Components on floor plans

4. Drawings for Donor Antenna and grounding
5. RF propagation modeling
6. Bill-of-Material (BOM)
7. Maintenance Service Contract
8. Statement of Work (SOW):
    a. The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
9. Acceptance Test Plan (ATP):
    a. The contractor shall submit an ATP that has been accepted by the Owner.

C. Submittal Requirements at Close Out
1. Drawings: Submit as-built drawings indicating:
    a. Donor antenna, grounding and lighting protection details
    b. Cable routing, splitters, couplers and coverage antenna locations
    c. Active component locations, layout and configuration
2. Test Reports
    a. PSN: Submit Accepted ATP reports confirming the requirements of Section 1.07 B have been met.
1. Field Reports:
    a. Submit sweep-testing results for all cable runs – DTF and Return Loss
2. Field Reports: Submit test results for all fiber runs.
3. Operation and Maintenance Data:
    a. Submit hardware and software manuals for all Active Components.
4. Warranty Documents:
    a. Submit for all manufactured components specified in this Section.
    b. Submit Contractor's System Warranty.
    c. Submit Manufacturer's Extended Warranty

1.14 QUALITY ASSURANCE

A. Qualifications: Contractor, and/or Sub-Contractors, shall have a minimum of 5-years full-time experience executing work of similar scope and complexity.

B. Certifications:
1. Passive Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.
2. Active Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.

1.15 WARRANTY

A. Manufacturer Warranty:
1. Splitters, Couplers and Coverage Antennas: 5-year limited warranty from date of system acceptance.
2. Coaxial Cable and Connectors: 10-year limited warranty from date of system acceptance.
3. Fiber-Optic Cable: 20-year limited warranty from date of system acceptance.
4. Active Components: The earliest of 1-year limited warranty from date of system installation or 15 months from date of shipment.

B. Contractor Warranty: Contractor shall warrant the system performance as specified in Section 1.10 for 1-year.

C. Manufacturers Extended Warranty:

1. The DAS shall be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified contractor. The certification program covers a certified system defined as a DAS installation performed by a certified contractor using components conforming to section 2.01 following all the manufactures recommendations, installation instructions and best practices. Manufacturer shall administer a follow-on program through the contractor to provide support and service to the purchaser.
2. The first part is an assurance program, which provides that the certified system will support current and future modulation formats in the frequency bands for which it is designed, during the warranty of the certified system.
3. The second portion of the certification is a 20-year warranty provided by the manufacturer and the contractor on all cable products within the system (fiber-optic cable, coaxial riser cable, plenum coaxial cable and associated connectors, etc.).
4. In the event that the certified system ceases to support the certified application(s), whether at the time of ATP, during normal use or when upgrading to additional frequency bands, the manufacturer and Contractor shall commit to promptly implement corrective action.
5. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacture the products used in the DAS.

1.16 MAINTENANCE

A. The Contractor shall provide an optional maintenance service contract, covering for a period of one-year: preventative maintenance, system monitoring, spares, fault mitigation, equipment repair, and response time.

B. Annual Testing:

1. As required by Code, the PSN shall be tested annually beginning one year from date of acceptance. Contractor shall provide pricing for additional service contract to conduct annual testing to verify cable integrity and operational capabilities. Such testing shall include a certified, written report attesting to the results.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: As permitted in Section 1.06.

2.02 COMPONENTS

A. Broadband Donor Antennas: Broadband Donor Antennas shall feature a multi-band design, accommodating frequencies in a single small antenna.

1. Electrical:
   a. Frequency bands in compliance with PSN
   b. VSWR ≤1.8
   c. Maximum input power: 100 watts
   d. Polarization: Vertical
   e. Impedance: 50 Ω
   f. Azimuth Pattern: As proposed by the manufacturer to meet the performance specifications in this Section.
2. Mechanical:
   a. Radome material: UV-protected ABS
   b. Pigtail cable: RG58
   c. Connector: 50 ΩN Type Female
   d. Mounting: Pole

3. Environmental
    a. Temperature: -40 °C to +60 °C
    b. Lighting protection: Direct ground
    c. Waterproof level: IP 66
    d. Wind Speed, maximum: 125 mph
4. Approved Manufacturer: in accordance with Section 1.06.

B. Fiber-Optic Cable and Connectors:
1. General Specifications:
    a. Cables shall be six-strand or greater, designed for point-to-point applications as well as mid-span access, and shall provide a high-level of protection for optical fiber installed in interior building environments.
    b. Higher optical fiber count cables shall utilize a sub-unitized design with color coded subunits for easy identification.
    c. Single-mode optical fibers shall be 8.3 µm and use standard colored tight buffered construction.
    d. The single-mode optical fiber shall be dispersion-un-shifted optical fiber that meets ITU-T G.652c standards.
    e. Cable shall provide optimum performance over entire wavelength range from 1260 to 1625 nanometers.
    f. Cable shall support new and emerging applications that utilize extended E band, 1360 to 1460 nanometers.
    g. Cable shall also support existing and legacy single-mode applications that traditionally operate in 1310 and 1550 nanometer regions.
    h. Fire ratings: Riser or plenum as required by AHJ
    i. Approved Manufacturer: CommScope, Corning or equivalent, in accordance with Section 1.06.

C. Fiber-Optic Pigtails:
1. General Specifications:
    a. To maintain channel integrity, optical fiber patch cords and pigtails shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots, and shall have same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtails shall be available with the following options as specified or indicated:
        1) Termination types: SC-APC
        2) Connector/cable configuration: Simplex and duplex
        3) Fire ratings: Riser or plenum as required by AHJ
        4) Patch cord outside diameters:
            a) 1.6 millimeters (0.063 inches) and 3.0 millimeters (0.118 inches)
        5) Pigtails: Ruggedized and tight-buffered optical fiber—0.9 millimeters (0.035 inches) outside diameter
        6) Lengths: As specified or indicated
        7) Approved Manufacturer: CommScope, Corning or equivalent, in accordance with Section 1.06.

D. Air Dielectric, Plenum Rated Cable:
1. Material Characteristics:
    a. Jacket: Halogenated, Fire-Retardant
    b. Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
    c. Inner Conductor Material: Copper-Clad Aluminum Wire

2. Electrical Characteristics:
   a. Impedance: 50 ± 2.0 Ω
   b. Frequency Band: 1 - 8800 MHz
   c. Peak Power Rating: ≥40.0 kW
3. Mechanical Characteristics:
   a. Diameter Over Jacket: ≤.627 in
   b. Minimum Bending Radius: ≤5 in
   c. One Time Minimum Bending Radius: ≤3 in
4. Attenuation Characteristics:

Frequency (MHz)	Attenuation (dB/100ft)
150	≤0.848
450	≤1.53

Table 1 - Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Approved Manufacturer: Andrew HL4RP-50A, AL4RPV-50A or equivalent, in accordance with Section 1.06.

E. Foam Dielectric Cable:
1. Material Characteristics:
   a. Jacket: Non-halogenated, Fire-Retardant Polyolefin
   b. Outer Conductor Material: Corrugated Copper
   c. Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube
2. Electrical Characteristics:
   a. Impedance: 50 ± 1.0 Ω
   b. Frequency Band: 1/2” Nominal: 1 - 8800 MHz, 7/8” Nominal: 1 - 5000 MHz
   c. Peak Power Rating: ≥40.0 kW
3. Mechanical Characteristics:
   a. Diameter Over Jacket: 1/2” Nominal: ≤.630 in, 7/8” Nominal: ≤1.1 in
   b. Minimum Bending Radius: 1/2” Nominal: ≤5 in, 7/8” Nominal: ≤10 in
   c. One Time Minimum Bending Radius: 1/2” Nominal: ≤2 in, 7/8” Nominal: ≤5 in
4. Attenuation Characteristics: 1/2” Nominal

Frequency (MHz)	Attenuation (dB/100ft)
150	≤0.815
450	≤1.447

Table 2 - Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Attenuation Characteristics: 7/8” Nominal:

Frequency (MHz)	Attenuation (dB/100ft)
150	≤0.417
450	≤.774

Table 3 -Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

6. Approved Manufacturer: Andrew LDF4-50A, FXL-540-NHR, FXL-780-NHR or equivalent, in accordance with Section 1.06.

F. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:
1. Approved Manufacturer: Andrew or equivalent, in accordance with Section 1.03.

G. BDA: When the AHJ dictates a BDA drive the DAS, the BDA shall be of modular design and use digital filtering to mitigate interference and accommodate multiple services for PSNs.

1. Characteristics
   a. Operating Temperature Range: -33 °C to +50 °C
   b. Chassis shall be of modular design with ≥4 frequency bands per 19" chassis. Chassis shall not exceed four Rack Units (RUs) in height.
   c. FCC Part 90.219 Type Classification: Class A narrowband for LMR/SMR/ESMR frequency bands
   d. Alarming: Shall support both SNMP and SMS using wireless modem
   e. Mounting Options: shall support rack, wall and pole mounting
2. Compliance:
   a. NFPA: The BDA shall comply with NFPA-1 2009 edition Annex O In Building Public Safety Radio Enhancement Systems.
   b. FCC: Shall be FCC type certified.
   c. Components shall meet NEMA 4 as required
3. Approved Manufacturer: Axell Wireless or equivalent, in accordance with Section 1.06.

H. Fiber-Optic Master Unit: When building size dictates an Active fiber DAS, the Fiber Optic Master Unit shall convert radio over coax to Radio-Over-Fiber (RoF) for distribution to Fiber-Optic Remote Units.

1. Characteristics
   a. Transmission Media: Single-mode fiber at 1310 nm
   b. Operating Temperature Range: +5 °C to +40 °C
   c. Impendence: 50 Ω
   d. Chassis:
      1) Enclosure shall be NEMA 4
      2) Shall be of modular design capable of supporting ≥32 Remote Units per 19", 4 RU chassis
      3) Shall support redundant power supplies
      4) Shall have the capability to remotely power the Remote Units via composite fiber-optic cable
   e. Automatic Gain Control (AGC): Shall provide AGC for optical loss compensation
   f. Optical Budget: Shall support ≤3 dB optical budget (~3 km or 2 miles)
   g. Auxiliary Channel: Shall provide an input to support 150 to 2700 MHz for future expandability
   h. Remote Supervision:
      1) Shall support the TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers
      2) Remote access shall be available via Point-to-Point Protocol (PPP), over circuit-switched/packet data and wired/wireless modems
      3) Each Active device shall be manageable via a Web GUI
      4) Auto Mapping: Each board position shall be automatically mapped during system turn-up

I. Fiber-Optic Remote Units: The Fiber-Optic Remote Unit converts the RoF signal back to radio over coax, as well as provides filtering so that multiple frequency bands can reside over the same passive cable and antenna infrastructure.

1. Characteristics
    a. Enclosure shall be NEMA 4
    b. Operating Temperature Range: +5 °C to +40 °C
    c. Impendence: 50 Ω
    d. Power Consumption: ≤105 watts, maximum
    e. MTBF (excluding external power supply): ≥160,000 hours

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

A. The contractor shall design, install, commission and test the DAS in accordance with the manufacturer's instructions and recommendations with the accepted SOW.

B. Locate equipment, antennas, splitters and supporting components as per contract Drawings (as modified by agreement in submittal set).

C. Install all cabling in a neat and orderly manner that meets or exceeds generally accepted practices as outlined in BICSI's *Standard for Installing Commercial Building Telecommunications Cabling.* All cable shall be supported in a manner that satisfies the requirements in *NEC*® Chapter 8.

D. Mount antennas per manufacturer's instructions and as per contract Drawings.

1.02 HEADEND EQUIPMENT INSTALLATION

A. Backboard mounted equipment shall be installed as per the manufactures instructions. Minimum of four attachment points shall be used. Fasteners are to be zinc coated or stainless steel and designed to support a minimum of twice the configured weight of the equipment.

B. Rack mounted equipment shall be installed in a dedicated 19" or 23" wide and 84" tall cabinet (manufacturer dependent) that is NEMA 4 rated. Cabinet shall be securely fastened to the floor with a minimum of Grade 5, 3/8" fasteners that utilize an internal expanding anchor into the concrete floor. On the ground floor, racks shall be installed utilizing an isolation kit to prevent direct contact with the concrete as well as bushings to isolate the floor anchors from the metallic components of the rack.

C. Comply with Seismic Zone requirements in terms of lateral bracing and attachment to ladder trays.

D. All metallic components shall be bonded to a known source of building system ground in accordance with the stricter of ANSI/TIA-607.B, the *NEC*® or local AHJ.

1.03 COORDINATION WITH OTHER TRADES

A. Coordinate the installation of suitable electrical power for all selected Headend components with Electrical Engineer. Power shall be of suitable voltage and amperage and dedicated to each Headend. PSN equipment must be protected by an interruptible power supply (UPS or code compliant generator) that provides standby power for 24 hours. Final design must satisfy the AHJ.

B. WSP may opt for UPS and require special input power considerations. Coordinate with Owner for final configuration and distribution of power.

C. Coordinate space requirements for termination of incoming fiber in the rack for each WSP selected.

1.04 ACCEPTANCE TESTING

A. Acceptance testing will be performed confirming the requirements of Section 1.10 have been met.

B. The Contractor shall complete the acceptance testing as prescribed in the Accepted Test Plan (ATP) submittal. Testing shall satisfy all requirements of the AHJ.

C. The contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.

END OF SECTION

COMMON WORK RESULTS FOR CCTV AND SECURITY

PART 1 GENERAL

1.01 DIVISION INCLUDES

A. Access Control

B. Intrusion Detection

C. Video Surveillance

D. Integration with AMX AV system, Lighting and DDC controls

E. Wiring

1.02 RELATED WORK BY OTHERS

A. All rough-in category 6a data cabling to support the system will be provided by Division 27 – Communications Horizontal Cabling

1.03 RELATED REQUIREMENTS

A. 27 4116 Integrated Audio Video Systems

B. 28 1313 Access Control Applications

C. 28 1316 Access Control Database Management

D. 28 1319 Access Control Infrastructure

E. 28 1326 Access Control Remote Devices

F. 28 1333 Access Control Interfaces

G. 28 1343 Access Control ID Management

H. 28 1613 Security Controls and Management Systems

I. 28 1619 Security Systems Infrastructure

J. 28 1633 Security Systems Remote Devices

1.04 SUMMARY

A. LABOR AND MATERIALS

1. Unless otherwise provided in the Drawings and Specifications, the Contractor shall provide and pay for all labor, materials, equipment, tools, utilities, construction equipment and machinery, transportation and other facilities and services necessary for the proper execution, operation and completion of the Work.

B. SPECIFICATION LANGUAGE

1. Specifications and notes are written in imperative and abbreviated form. Imperative language of the technical specifications is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting “shall”, “shall be”, “the Contractor shall”, and similar mandatory phrases by inference. The words “shall be” shall be supplied by inference where a colon (:) is used within product specifications.

C. DRAWINGS AND SPECIFICATIONS

1. Contractor shall be provided up to three (3) sets of the Drawings and Specifications for their use. Additional sets, if requested by Contractor, shall be furnished to the Contractor for the actual cost of reproduction.

2. Contractor shall carefully study the Drawings and Specifications, and shall at once report any error, unforeseen circumstances, inconsistency or omission he may discover.

3. The Eugene School District Project Manager shall be the interpreter of the requirements of the Drawings and Specifications, subject to the final approval of Eugene School District. All interpretations and opinions of the Security Consultant shall be made in writing or in the form of drawings.

D. INTENT AND CORRELATION

1. The intent of the Project Drawings and Specifications is to include all items necessary for the proper execution and completion of the Work.
2. The Project Drawings and Specifications are complementary, and what is required by any one shall be as binding as if required by both.

1.05 REFERENCES

A. Submit the names and phone numbers of customers for at least three other projects of similar size and complexity using similar technologies.

1.06 DEFINITIONS

A. Words that are in common use are used throughout the Drawings and Specifications, except:

B. Words which have well-known technical or trade meanings are used in accordance with such recognized meanings.

C. Whenever the following listed words and phrases are used, they shall be mutually understood to have the following respective meanings:

D. The words “as indicated.” means: as shown on the Drawings, and in accordance with the Specifications.

E. The words “as required.” means: as required to provide a complete and satisfactory Work in full conformance with the Drawings and Specifications.

F. The word “New” means: new Work to be provided by Contractor.

G. The word “Provide” means: furnish, install, connect, test and make ready for use.

H. The words “Relocate existing” means: remove existing item from present location. Reinstall, re-connect, and test existing item and make ready for use at new location as shown on the Drawings.

I. The words “Remove existing” means: remove existing item and return item to Eugene School District.

J. The word “Replace” means: remove existing item and return item to Eugene School District. Provide new item as indicated.

K. The word “Work”: The Work is the completed construction required by the Drawings and Specifications, and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.

L. The word “Furnish” means: supply item as specified.

1.07 CONTRACTOR DESIGN REQUIREMENTS

A. The Project Drawings represent the level of system design to be provided by Eugene School District. Contractor shall provide all additional system design work required, including:

1. Point-to-point equipment hook-up information.
2. Equipment mounting details
3. Design of equipment cabinets
4. Other detailed design work required.

B. Contractor's design shall conform to all applicable codes and ordinances. All electrical design, including the sizing and placement of conduit, raceways and conductors, shall be in accordance with NFPA 70: National Electrical Code, current version, unless local codes establish more stringent requirements.

C. Contractor's design work is subject to review and approval by Eugene School District's Project Manager.

D. Contractor's design shall also include:

E. Complete "as-built" documentation of all security systems, including documentation of existing equipment, wiring, conduits, and raceways.

F. Other Work as defined within the Project Drawings and Specifications.

1.08 SUBMITTALS

A. Product Data

1. Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures

1. Provide submittals to Eugene School District's Project Manager.
2. Submit three (3) copies of each submittal.

C. Shop Drawings

1. General Shop Drawings for the project as described elsewhere.
2. Provide other Shop Drawings only if specifically requested by Eugene School District's Project Manager.

D. Manufacturers Installation and Programming Instructions

1. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

1.09 PROJECT RECORD DRAWINGS

A. Definition: Project Record Drawings are drawings that completely record and document all aspects and features of the Work. (Also known as "as-built" drawings.)

B. The purpose of Project Record Drawings is to provide factual information regarding all aspects of the Work, to enable future service, modifications, and additions to the Work.

C. Project Record Drawings are an important element of this Work. Contractor shall accurately maintain Project Record Drawings throughout the course of this project. Project Record Drawings shall include documentation of all Work, including the documentation of existing equipment, wiring, conduits, and raceways that are to be reused in the Work.

D. Eugene School District Project Manager shall furnish Contractor with two (2) sets of site plans for Contractor's use in preparing Project Record Drawings. One set shall be used as a working set; the other shall be used to prepare the final record set.

E. Contractor shall maintain the working set of Project Record Drawings at the project site throughout the course of the Work. The working set shall be updated on a daily basis as the Work progresses.

F. Project Record Drawings shall accurately show the physical placement of the following:

1. Equipment and devices
2. Junction and pull box locations.
3. Interfaces to external equipment
4. Connections to power and data circuits

G. Project Record Drawings shall show the physical placement of each device and conduit or aerial center line, to be accurate to within one foot (1') of the nearest landmark. Where the site plan furnished by Eugene School District Project Manager conflicts with actual conditions, Contractor shall amend site plan as required. Indicate exact description of conduit runs (above ground, two foot trench, along outside wall of building, etc.).

H. Project Record Drawings shall show wire and cable runs, zone numbers, tamper circuit configuration, panel/circuit breaker numbers from which equipment is powered, and splice points. Such information may be shown on the site plans.

I. Project Record Drawings shall be available for inspection by Eugene School District Project Manager on a daily basis. Incomplete or inaccurate Project Record Drawings may be cause for delay of Contractor's payment.

J. Upon completion of Work, and prior to Final Acceptance, Contractor shall prepare and submit to Eugene School District Project Manager a final record set of Project Record Drawings. This set shall consist of all data transferred from the working set, supplemented by Riser Diagrams and other information. The final record set of Project Record Drawings shall be drafted by a skilled draftsperson, under the supervision of Contractor. All final Project Record Drawings shall be provided to Eugene School District.

K. System Documentation

1. Definition: System Documentation is a complete collection of all installation, programming, operation, and maintenance manuals and work sheets relating to the equipment provided as part of the Work.
2. Contractor shall maintain a file of System Documentation at the project site throughout the course of the Work. Such file shall be updated with new information as equipment is received and installed. System Documentation shall be available for inspection by Eugene School District Project Manager on a daily basis.
3. Upon completion of Work, and prior to final Acceptance, Contractor shall prepare and submit to Eugene School District Project Manager three (3) sets of System Documentation.

L. Closeout Submittals

1. Provide a set of as-built drawings and manuals to the Eugene School District Project Manager
2. As-Built Drawings
3. Mounting Details
4. Product Data
5. Installation Manuals
6. Operating Manuals
7. Maintenance/Service Manuals

M. Provide the Eugene School District Project Manager- with all programming sheets, keys to the equipment cabinets, as-built drawings, operating manuals, maintenance/repair manuals, spare fuses, all programming sheets and keys to the equipment cabinets, tools for tamper-resistant enclosures and tools for manual resetting devices.

1.10 QUALITY ASSURANCE

A. Qualifications of Contractor

1. Contractor shall be an installation and service contractor regularly engaged in the sale, installation, maintenance and service of access control systems.
2. Contractor shall have three years' experience with the installation, start-up and programming of systems of a similar size and complexity to the one proposed.
3. Contractor shall be a factory authorized dealer of the system proposed.

B. Supervision of Work

1. Contractor shall employ a competent Project Manager to be in responsible charge of the Work and be on project site during the execution of the Work.
2. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.
3.

C. Qualifications of Technicians

1. All electronic systems Work shall be performed by electronic technicians thoroughly trained in the installation and service of specialty low-voltage electronic systems.
2. Journeyman electricians may be used to install conduit, raceways, wiring, and the like, provided that final termination, hook-up, programming, and testing is performed by a qualified electronic technician, and that all such Work is supervised by the Contractor's Foreman.
3. All incidental Work, such as cutting and patching, lock hardware installation, painting, carpentry, and the like, shall be accomplished by skilled craftsperson regularly engaged in such type of work. All such Work shall comply with the highest standards applicable to that respective industry or craft.
4. All 120 VAC power wiring and connections are to be performed by a qualified Journeyman Electrician, licensed to perform such Work in the Eugene School District.

D. Subcontractors

1. Definition: A Subcontractor is a person or entity who has a direct contract with the Contractor to perform any of the Work at the site.
2. Use of any Subcontractor is subject to the approval of Eugene School District. The Contractor shall identify all Subcontractors on the Bid Form. The Contractor shall make no substitution for any Subcontractor previously selected without approval from Eugene School District.
3. Contractor's Foreman shall be on the project site daily during all periods when Subcontractors are performing any of the Work. Contractor's Foreman shall be in responsible charge of all Work, including any Work being performed by Subcontractors.
4. By an appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by the terms of the Drawings and Specifications, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these documents, assumes toward Eugene School District.

E. Supervision and Construction Procedures

1. The Contractor shall supervise and direct the Work, using their best skill and attention. Contractor is solely responsible for all construction means, methods, and techniques.
2. The Contractor shall employ a competent foreman who shall be in attendance at the project site during the progress of the Work. The foreman shall represent the Contractor and all communications given to the foreman shall be as binding as if given to the Contractor.

F. Regulatory Requirements

1. All Work is to conform to all building, fire, and electrical codes and ordinances applicable in the Eugene School District. In case of conflict between the Drawings/Specifications and codes, the codes shall govern. Notify Eugene School District Project Manager of any such conflicts.
2. Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. Contractor shall prepare, at Contractor's expense, any documents, including drawings that may be required by regulatory agencies.

G. Permits

1. The Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Security of Contractor’s Tools and Equipment: Eugene School District is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

1.12 PROJECT/SITE CONDITIONS

A. Environmental Conditions

1. Power: Electrical power will be supplied by Eugene School District to the extent that the usage is compatible with available facilities in the vicinity of the work.
2. Parking: Eugene School District reserves the right to limit or restrict Contractor parking based upon the daily requirements of the other contractors on site.
3. Dust Control: Make provisions to control all dust, dirt, and foreign material caused by the performance of the Work.
4. Notify Eugene School District immediately of any damage or possible damage to any other equipment.

B. Clean-Up

1. Contractor shall clean-up, on a daily basis as the Work progresses, all dirt, dust and debris caused by Contractor’s operations. Clean-up shall be completed by the end of each workday to the satisfaction of Eugene School District's on-site representative.
2. In the event that Contractor fails to clean-up, Eugene School District may elect to have clean-up performed by others, with the costs of such clean-up being charged to the Contractor.

C. Construction Aids

1. Definition: Construction Aids are facilities and equipment required by personnel to facilitate the execution of the Work. Construction Aids include scaffolds, staging, ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, protective equipment, and other such facilities and equipment.
2. Contractor shall provide all Construction Aids required in the execution of the Work. Construction Aids that are the property of Eugene School District or other contractors shall not be used without permission.
3. Storage of Construction Aids shall be coordinated with Eugene School District's on-site representative.

D. Safety

1. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work.
2. Contractor shall comply with all local, state, and federal regulations and laws for the safety of the work place.

E. Existing Conditions

1. Eugene School District does not warrant the condition of any portion of the existing wiring, conduit or raceway systems. Prior to submitting their proposal, Contractor shall examine all existing conditions and determine to what extent the existing wiring, conduit, and raceway systems may be reused.

1.13 SEQUENCING

F. Description

1. This implementation plan describes the general approach that shall be followed in order to minimize the time for the access control systems to be operational.

G. Approach

1. Contractor shall plan and schedule all work in such a sequence as to minimize the time before the system is operational. The following is a suggested work sequence:
2. Order all equipment needed and notify any subcontractors to schedule their participation.
3. Perform all system layout work.
4. Insure there are an adequate number of power receptacles available to operate all security equipment and coordinate with Eugene School District as to where power is available.
5. Provide shop drawings to verify location of all equipment, conduit runs, power connections, etc. Submit shop drawings to Eugene School District Project Manager.
6. Coordinate with Eugene School District to provide space in each building's Communications Room for mounting of processors.
7. Provide training on how to fill out the programming sheets for access levels.
8. Prepare and pre-test all equipment to the greatest extent possible.
9. Install all equipment.
10. Provide training on the programming other various options.
11. Test and inspect all systems.
12. Perform all other Work as required.
13. Perform the Acceptance Test.
14. Provide training.
15. Provide as-built drawings.

1.14 SCHEDULING

A. The Contractor, within five (5) days after being awarded the contract, shall prepare and submit for Eugene School District's information, an estimated progress schedule for the Work. The progress schedule shall be related to the entire project, and shall indicate start and completion dates.

1.15 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Eugene School District, or acts of god.

E. Contractor shall promptly respond to Eugene School District's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from Eugene School District, but in no case shall service response exceed 24 hours from time of request.

1.16 OWNER'S INSTRUCTIONS

A. Coordination with Eugene School District

1. Contractor shall closely schedule and coordinate their activities with designated Eugene School District representatives.

2. Contractor shall provide Eugene School District's Project Manager with a work plan on a weekly basis. Such work plan will describe locations of intended activities, types of activities, and potential conflicts to facility operations.

B. District's Right to carry out the Work

1. If the Contractor defaults or neglects to carry out the Work in accordance with the Project Drawings and Specifications and fails within seven days after receipt of written notice from Eugene School District to commence and continue correction of such default or neglect with diligence and promptness, Eugene School District may, after seven days following receipt of an additional written notice and without prejudice to any other remedy Eugene School District may have, make good such deficiencies. In such case, an appropriate Change Order shall be issued deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies.

C. Minor Changes in the Work

1. Eugene School District shall have the authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Project Drawing and Specifications. Such changes shall be provided by written order.

1.17 COMMISSIONING

A. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

B. Contractor shall submit a request for the Acceptance test in writing to the Eugene School District Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.

C. During Acceptance test, Contractor shall demonstrate all equipment and system features to Eugene School District. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by Eugene School District.

D. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. Eugene School District Project Manager will prepare a list of any such deficiencies observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to Eugene School District Project Manager for another Acceptance Test.

E. If, at the conclusion of the Acceptance Test, all Work is found to be acceptable and in compliance with the Project Drawings and Specifications, Eugene School District Project Manager will issue a letter of Acceptance to Contractor and Eugene School District.

1.18 MAINTENANCE

A. Provide full procedures for all database back-ups.

B. Provide full procedures for server/workstation hard drive maintenance, such as defrag, etc.

C. Provide full procedures for maintaining physical and software firewalls.

D. Provide full procedures for upgrading software.

E. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

2.02 RELATED REQUIREMENTS.

A. Product Availability

1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into their proposed Contract Time.

2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify their ability to procure the products specified prior to submitting a proposal.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.

B. The Contractor must be a factory authorized dealer with the proposed manufacturer.

C. The Contractor’s installers and technicians shall also be factory trained and certified to perform such tasks.

3.02 EXAMINATION

A. The Contractor shall be required to visit the installation site prior to bidding the job.

B. The Contractor shall report any discrepancies between the Specifications, Drawings, and Site Examination prior to the Bid Opening Date.

3.03 PREPARATION

A. The Contractor shall order all required parts and equipment upon notification of award of the Work.

B. The Contractor shall bench test all equipment prior to delivery to the job site.

C. The Contractor shall verify the availability of power where required. If a new source of power is required, a licensed electrician shall be used to install it.

D. The Contractor shall arrange for obtaining all programming information including access times, free access times, door groups, operator levels, etc.

E. The Access Contractor shall coordinate with the Door Hardware Contractor requirements at each door equipped with intrusion or access control components.

3.04 INSTALLATION

A. The Contractor shall coordinate with the Eugene School District's IT Department when connecting to their network.

B. The Contractor shall carefully follow the instructions in the manufacturers' Installation Manual to insure all steps have been taken to provide a reliable, easy to operate system.

C. Perform all Work as indicated in the Drawings and Specifications.

D. All communications cables shall be kept away from power circuits.

E. The Contractor shall also execute adequate testing of the system to insure proper operation.

F. The Contractor shall provide adequate training of the system users to insure adequate understanding to prevent operating errors.

G. Coordinate with Division 27 for connections to paging, intercom and video systems for lockdown, lockout and emergency notifications.

H. Coordinate with Division 28 fire alarm system for release of magnetically held doors.

3.05 WORKMANSHIP

A. Comply with National Electric Code® as well as recognized industry standards, except when specified requirements indicate more rigid standards or more precise workmanship.

B. Perform Work with persons experienced and qualified to produce workmanship specified.

C. Maintain quality control over suppliers and Subcontractors.

D. Quality of workmanship is considered important. Eugene School District Project Manager will have the authority to reject Work which does not conform to the Drawings and Specifications.

3.06 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.

3.07 GROUNDING

B. Provide earth-grounding of equipment as required by equipment manufacturer. Earth ground shall be connected to ground rod or approved cold water pipe. Electrical or telephone ground connections shall not be used as earth grounds. Connections to mounting posts or building structural steel shall not be used as earth grounds.

3.08 POWER TO SECURITY EQUIPMENT

A. Power all equipment from 120 VAC circuit dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded "Security Equipment - Do Not Operate", or equivalent.

B. All plug-in transformers shall be located at the security control panels. Secure all low-voltage plug-in transformers to outlet with screw or strap. Clearly label all transformers to identify purpose and use.

3.09 CUTTING AND PATCHING

A. The Contractor shall be responsible for all cutting, fitting or patching that may be required to complete the Work.

3.10 PLYWOOD BACKING

A. Install the processor(s), power supplies, and all other related equipment on a plywood backboard (installed by Others) in the nearest Telecommunication Room.

3.11 FIELD QUALITY CONTROL

A. Upon reaching Substantial Completion, perform a complete test and inspection of the system. If found to be installed and operating properly, notify Eugene School District of your readiness to perform the formal Test & Inspection of the complete system.

B. Submit the Record Drawings (as-builts) to Eugene School District for review prior to inspection.

C. During the formal Test & Inspection (Commissioning) of the system, have personnel available with tools and equipment to remove devices from their mounts to inspect wiring connections. Provide wiring diagrams and labeling charts to properly identify all wiring.

D. If corrections are needed, the Contractor will be provided with a Punch-List of all discrepancies. Perform the needed corrections in a timely fashion.

E. Notify Eugene School District when ready to perform a re-inspection of the installation.

3.12 MANUFACTURER PROFESSIONAL SERVICES

A. Contractor shall coordinate with the manufacturer to provide the manufacturer's professional services team to assist the Owner in coordinating the interfaces between the security management system and other on-site systems as necessary.

B. Professional Services personnel shall be employed by the manufacturer of the security management system and shall be thoroughly knowledgeable of the security management system applications.

C. Professional Services personnel shall be on-site and available to meet with Owner's representatives for a period of not less than two consecutive days. On-site visit shall be scheduled at the convenience of the Owner.

END OF SECTION 28 0500

COMMISSIONING FOR FIRE ALARM

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 provisions of Section 26 05 00, Common Work Results for Electrical apply to work specified in this Section.

C. The Work of this Section is supplemental to and does not supersede any other requirements of the Contract Documents.

1.2 SUMMARY

A. The commissioning process is described in Section 01 91 13 General Commissioning Requirements.

B. Provide all labor and materials required to complete the commissioning of those Division 28 systems and equipment identified as Commissioned Systems and Equipment in Section 01 91 13 General Commissioning Requirements.

C. Related Sections include:
   1. Section 01 91 13 General Commissioning Requirements.
   2. All Sections of Division 28.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.4 COMMISSIONING SCOPE OF WORK - COMMISSIONING AGENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

1.5 COMMISSIONING SCOPE OF WORK - CONTRACTOR

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Section 01 91 13 General Commissioning Requirements.

PART 3 - EXECUTION

3.1 MEETINGS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.2 INSTALLATION, CHECK-OUT, START-UP AND PREFUNCTIONAL CHECKS

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.3 FUNCTIONAL TESTING

A. Refer to Section 01 91 13 General Commissioning Requirements.

3.4 TRAINING OF FACILITY OPERATING STAFF AND BUILDING OCCUPANTS

A. Refer to Section 01 79 00 Demonstration and Testing.

END OF SECTION

ACCESS CONTROL APPLICATIONS

PART 1 GENERAL REQUIREMENTS

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 SECTION INCLUDES

A. Head-end Software

1.03 RELATED SECTIONS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1316 Access Control Database Management

C. 28 1319 Access Control Infrastructure

D. 28 1326 Access Control Remote Devices

E. 28 1333 Access Control Interfaces

F. 28 1343 Access Control ID Management

G. 28 1613 Intrusion Detection Panels

H. 28 1619 Intrusion Detection Remote Devices

I. 28 1633 Intrusion Detection Interfaces

1.04 SYSTEM USER REQUIREMENTS

A. System Overview

1. The contractor shall provide and install a new integrated security management system that shall provide a simple and easy-to-use graphical user interface. The system shall provide local operational control of all access points and alarm sensors.

2. The system shall carry the UL mark, and shall meet the requirements of UL-294.

3. The manufacturer shall be ISO 14000 and 14001 certified indicating their commitment to conserve energy and reduce waste.

4. The manufacturer shall be a Microsoft Certified Gold Partner. System shall meet Microsoft requirements for “Designed for Microsoft Windows Server 2011” or later and “Designed for Windows 7”, or “Windows 8”.

5. The manufacturer of the proposed system shall require resellers to pass a formal training program prior to being certified as authorized to sell and install the system. Such certification shall require annual re-qualification. The system integrator proposing the system shall be in possession of such a certification.

6. The Security Management System (SMS) client and server software shall be used in conjunction with intelligent controllers to provide a distributed access control and alarms monitoring system. In the event of a communications failure between the host server and the field controllers, the controllers shall continue to make local access control decisions and save all transactions in memory until communications are restored. At that time the controller shall upload all stored transactions to the server.
7. The SMS shall seamlessly integrate the functions of access control, alarms monitoring and response, digital video imaging, badge design/creation, and visitor management. All SMS components shall run in an integrated application environment as part of a single application.

B. Bandwidth Utilization

1. The proposal shall include documented manufacturer's evidence of network bandwidth utilization including plots and supporting data, covering all aspects of normal system operation. Proposal submissions without supporting documentation shall not be considered or evaluated.

C. Required Standard Software Features

The following software features shall be part of the standard product offering without requiring additional purchase or licensing.

1. The installation of the server and client software shall utilize a "wizard" interface to guide users through the appropriate installation steps.
2. The SMS shall start up as part of the Operating System. The SMS server shall communicate to all clients (operator workstations and field hardware) through WIN32/WIN64 services. The SMS shall run as a service in the OS, and there shall be no requirement to run an application after the operating system is ready.
3. The SMS shall support a Graphical User Interface that minimizes training needs for even inexperienced users. The software shall include on line help displays to eliminate operator reference manuals.
4. It shall be possible to select any function, within a given Operators permission, independent of the currently displayed screen. Functions will be accessed via tool bar Icons, which will include "Help" prompts that will appear when the mouse pointer dwells on the selection button. It shall also be possible to link any standard Windows application to a custom toolbar icon.
5. The system shall support an unrestricted number of time codes. A time code is defined as a set of hour definitions – one assigned to each day of the week (including Saturday and Sunday) as appropriate, and assigned to the various types of holidays (exceptions) defined in the system.
6. The system shall support a minimum of 9 holiday types. A holiday type shall be assignable to an unrestricted number of dates on the calendar.
7. The system shall be scalable to a multiple-server implementation where each region (either geographical or logical) has a server capable of making local decisions and configuration changes.

8. Operator Permissions

a. System operators shall be associated with a log in Name and Password. A system option will determine whether strong operator passwords will be used. The minimum definition of a strong password shall be a password that contains at least one upper case character, one lower case character, one numeral and one punctuation mark, with a minimum password length of six characters. Additionally the password cannot contain any full word of the operator's username.

b. The operator's account shall be assigned to a role in the system. The role is a permission profile. This will determine the functions that shall be available to that operator when logged-on to the system. Each operator is required to only see the functions for which s/he has access. The system shall support an option to hide Personal Identification Numbers of cardholders when an operator is viewing a record.

c. Card record data entry shall be divided into operator permission areas, allowing separate permission categories to be assigned for the viewing of personal data, ID badge printing and access right management.

d. For all operators, a means of re-arranging their Icon tool bar shall be provided to allow the most frequently used Icons to be repositioned by the operator.

e. The system shall store operator preferences based on logon information. This feature shall allow an operator to work with their preferred configuration independent of which workstation they occupy.

f. The system shall support an option to reset all window layouts to a pre-defined "Home Screen".

D. Required Available Software Options

1. Threat Level Manager Option

a. The TLM option shall provide the ability to make system-wide changes by simply changing the threat level.

b. The Threat Level shall be selected from one of five levels that can be labeled and defined by the user. Each threat level shall also have a specified color associated.

c. The present state of the system threat level shall be visible from any view within the software.

d. The system shall restrict the ability to change threat level to the appropriate operator(s).

e. The system shall allow the configuration option to require the approval of two authorized operators to change the threat level.

f. The ability to change the threat level shall be integrated into the site map by right clicking on an appropriate icon.

g. The system shall automatically disable access rights for individuals that have a threat level threshold below the selected level. The same access rights will automatically be enabled when the threat level changes to a level below their threshold.

h. The SMS directory synchronization shall support multiple, disparate directories and flat files simultaneously, and interact with each through agents.

2. XML Developer's Toolkit Option

The system shall support the ability to send and receive commands to/from external web services through an XML interface, the XML Developer's Toolkit. All operations through this interface shall be accompanied by a logon username and password that will be associated in the security management system with operator privileges, which will limit what is permissible. The interface shall use standard security provided by web services.

a. The XML Developer's Toolkit shall support the import of cardholder details. An external software system may use web services, for example, to add new cardholders, delete cardholders, modify existing cardholder data, make cards inactive, and change access rights.

b. The XML interface shall allow an external software system to obtain the details of cardholders that are already in the SMS database.

c. The XML interface shall allow an external software system to view, acknowledge, and clear outstanding SMS alarms.

d. The XML interface shall allow an external software system to send a command to a device already defined in the SMS (e.g. to open a door or switch on a CCTV camera).

e. The XML interface shall allow an external software system to view the status of an SMS device (e.g. to determine whether a door is locked or unlocked).

f. The XML interface shall allow an external software system to import alarms from external equipment, such as intrusion systems.

3. Thin Client Access Option

a. The system shall provide for an option of thin client access to the security management system. The thin client interface shall utilize Microsoft Terminal Services to provide the same look and feel of the thick client to minimize training time and expense. The thin client shall be capable of the same functionality of a thick client with the exception of functionality that requires access to ports on the thin client computer – Microsoft Terminal Services does not sufficiently support such access.

4. Thin Client Visitor Management Access Option

a. The system shall provide for an option of thin client access specifically for the visitor management system. The thin client interface shall utilize Microsoft Terminal Services to provide the same look and feel of the thick client to minimize training time and expense. The thin client shall be restricted to Visitor Management functions.

1.05 SUBMITTALS

A. Product Data

Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures

1. Provide submittals to Eugene School District's Project Manager.

2. Submit three (3) copies of each submittal.

C. Manufacturers Installation and Programming Instructions

Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

1.06 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Eugene School District, or Acts of God.

1.07 MAINTENANCE

A. Provide full procedures for all database back-ups.

B. Provide full procedures for maintaining physical and software firewalls.

C. Provide full procedures for upgrading software.

D. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his proposed Contract Time.

2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.

2.02 ACCESS CONTROL SYSTEM - SYSTEM SPECIFICATIONS

A. Head-end Hardware and Software, the current District standard system Lenel. No substitutions will be allowed. Access software licenses are Owner Provided.

B. Access Door Control interface – equip for card access doors as shown on the drawings.

C. Coordinate ADA interface operation with Division 8.

D. Interface SMS system with the DMP XR550N intrusion panel.

PART 3 EXECUTION

3.01 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.

3.02 INITIAL PROGRAMMING AND CONFIGURATION

A. Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Consultant and Owner to determine operating parameters.

B. Contractor shall develop and input system graphics, such as maps and standby screens. Owner shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings, in the form of AutoCAD® .DWG or .DXF files, as the basis for the creation of maps.

C. Owner, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.

D. Contractor shall maintain hard copy worksheets which fully document the system program and configuration. Worksheets shall be kept up to date on a daily basis by Contractor until final Acceptance by Owner. Worksheets shall be subject to inspection and approval by Owner. Provide final copies to Owner prior to Project Close-out.

3.03 TRAINING

A. Contractor shall provide complete operator training on the Security Management System. Training shall consist of 2 hours of classroom instruction for ten people selected by Owner, plus two (2) hours of individual hands-on training for each of ten people selected by Owner. Hands-on training shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.

B. Training shall cover all operating features of the system, including the following:

1. System set-up and cardholder database configuration.
2. Access control features
3. Alarm monitoring features
4. Report generation and searches
5. Card management and Badge Design/Printing
6. Routine maintenance and adjustment procedures

C. Training sessions are to be held at Owner's facility, and are to be scheduled at the convenience of Owner. Contractor shall provide written training outline and agenda for each training session prior to scheduling.

D. Weekly format of training sessions shall be as follows:

1. Monday: 2 hour Control Center Training
2. Tuesday: 2 hour System Administrator Training
3. Wednesday: 2 hour System Administrator Training
4. Thursday: 2 hour System Administrator Training
5. Friday: 2 hour Control Center Training

E. Contractor shall provide written training materials for each of ten (10) people.

3.04 OPERATOR REFRESHER TRAINING

A. Contractor shall provide complete operator training on the Security Management System. Two types of operator training shall be provided:

1. Contractor shall provide follow-up training after project closeout.
2. Training as requested by the Owner shall take place within 180 days of project close out.

B. Training sessions shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.

C. Training sessions are to be held at Owner's facility, and are to be scheduled at the convenience of Owner. Some training sessions may be required to be held during evening hours and on weekends to accommodate users whose schedule does not permit attendance during regular hours.

D. Contractor shall provide written training outline and agenda for each training session prior to scheduling.

END OF SECTION – 28 1313

ACCESS CONTROL SYSTEMS DATABASE MANAGEMENT

PART 1 GENERAL REQUIREMENTS

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 SECTION INCLUDES

A. Head-end Software for Security Management Systems, (SMS).

B. Integration to the existing Owner security database.

1.03 RELATED SECTIONS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1319 Access Control Infrastructure

C. 28 1326 Access Control Remote Devices

D. 28 1333 Access Control Interfaces

E. 28 1343 Access Control ID Management

F. 28 1613 Intrusion Detection Panels

G. 28 1619 Intrusion Detection Remote Devices

H. 28 1633 Intrusion Detection Interfaces

1.04 SYSTEM USER REQUIREMENTS

A. Required Access Control Hardware Features

1. The SMS intelligent database controller shall support a minimum of 10,000 cardholders with expansion capabilities of up to 50,000 cardholders.
2. The SMS intelligent database controller shall support a minimum of 65,000 offline transactions.
3. The SMS hardware shall be comprised of modular components that connect over standard interfaces to one another. There shall be database storage and processing module (DBU), and once data has been downloaded to the DBU it shall locally make access control decisions. Access granted or denied decisions shall be made in under 0.5 seconds.
4. The DBU shall store firmware in non-volatile flash memory to allow for convenient updates through the head-end software application. The DBU shall store the cardholder and configuration database information in battery-backed memory so that loss of primary power will not cause the loss of the database.
5. The SMS hardware shall be capable of expansion via 2-, 4-, and 8- door controllers (DC). Door controllers shall support one or more input/output module “daughter” card that requires no additional addressing and provides 8 monitored input points or 8 auxiliary output points.
6. The DBU shall support configurations that include: 16 card readers, 96 monitored input points, or 96 auxiliary output points.

7. There shall be an intelligent controller option to provide control of 8 readers/doors from a single circuit board (communications, memory, CPU, and reader/door functions integrated) with an available 8-reader/door add-on to provide a 16-door controller from two circuit boards. The 8-door controller shall provide an integrated on-board RS-232 interface, and shall have provisions for modular expandable memory.
8. System must support the installation of readers at any distance from 3 feet to 1000 feet from the reader interface board. Systems that require additional, separately mounted components to achieve the requirement shall not be acceptable.
9. When using the vendor's proprietary readers, the SMS shall optionally annunciate door forced and held conditions using the reader's onboard sounder, Systems that do not offer this behavior, or that require additional wiring, use additional relay outputs, or require external sounders to accomplish it shall not be acceptable. This requirement applies only to non-biometric reader devices.
10. Efficient Memory Management
    a. Controllers shall be capable of supporting cardholder populations of at least 250,000, or be configured to a learning mode that allows the cards most frequently used to have their access rights stored locally in the panel's memory.
    b. When a card is presented which is not resident in the local panel, a verification request shall be made to the central database; if the card is valid the details shall be downloaded. If the card memory is full, the card with the oldest transaction date shall be deleted to make space for the card requested. This shall allow automatic management of cardholders, based upon frequent users having "instant" response and infrequent users learned when required.
11. Database Synchronization
    a. To ensure synchronization of the distributed controllers' databases with a region's main database an internal checking process shall be provided within each controller. In the event of corruption of a controller's local database then it shall be able to detect this condition and automatically request the relevant data to be downloaded from its local server. This action shall not require Operator intervention.
    b. The system shall continue to provide access control functionality during this re-synchronization process.
12. Door lock release relays shall be minimally rated for 3 A @ 30 VDC.
13. Readers supporting various technologies shall provide data from card presentations through a door control unit (DCU) that includes the electrical interface to the reader as well as inputs for door sensors and form C relays for outputs.
14. The DCU shall support Wiegand communications to the reader. In order to provide higher levels of security, the DCU shall support bi-directional, supervised, and encrypted communications to the reader. Door controllers that do not support encryption and supervision of reader communications are not considered equal.
15. The controller shall support a direct serial connection to the Network Video Server (NVS) for alarm transmission.

16. Clients
    a. The system shall support up to 10 clients to suit growing enterprise requirements. The system shall provide the means for multiple operators to simultaneously administer the system from convenient locations connected via a local area network (LAN) or across a wide area network (WAN).
    b. Clients shall not use mapped drives for server connections.
    c. Clients shall not use UDP messaging.
    d. System shall support a minimum of two pc monitors per client. The system shall additionally store the last position and size of all open dialog boxes and screens upon exiting the application on a per operator basis. The next time the operator logs into the application, the screen positions shall be restored. Such operation shall be independent of which workstation the operator uses.
17. Serial Device Interface
    a. The software shall allow the definition of ASCII commands to be sent out over a computer serial port (physical or virtual) or through the RS-232 interface of the DBU. These serial commands shall be available through the user interface as well as in the conditional logic described herein.
18. Automatic Holiday Override
    a. The software shall be programmed by the operator to recognize special or holiday dates, which in turn can be linked to operational changes in how the site is to be managed on these specific days. This feature shall notify a system operator of individual holiday dates up to seven days prior provides a useful check on the date's current validity. Multiple types of holiday dates shall also be provided so that partial days or early closing requirements on specific dates can be accommodated.
    b. The SMS shall provide a calendar function to enable scheduling of events up to five (5) years into the future.
19. System Partitioning
    a. The access point readers, monitor points, and auxiliary outputs shall be managed on a partition basis by simply defining which devices are to be included in a partition.
    b. The SMS shall be supplied with the ability to manage up to 64 partitions, and shall have an option to manage up to 999 partitions.
    c. Operator permissions shall be created and assigned globally or by the owning company. When created and assigned globally an Operator's password shall be associated with one or more companies.
20. Alarm Management
    a. Alarm handling shall be efficiently managed with up to 99 priority levels and user definable instruction messages to ensure the operator monitoring the site takes appropriate responses. The facility shall have the ability to customize audible alerts for each type of alarm is provided using standard or custom generated multimedia wave files. Each alarm type shall also be presented in a user-defined color.
    b. The SMS shall be optionally configured to require operator comments when acknowledging alarms.
    c. The SMS shall support the ability to selectively choose alarms to acknowledge and/or clear.

d. Each alarm shall be capable of linking video from digital video recorders (if applicable) for incident playback.
e. The Alarm Monitor screen shall provide an indication that cardholder information is available for a specific alarm. A “Card” button shall be available that when pressed will display the cardholder badge image.
f. Alarm monitor screen shall support the display of alarm statistics, shall provide up to ten alarm filters to be displayed in different tabs on the alarm screen, and shall provide the ability to sort based on each different column.
g. Each alarm shall be time-stamped in the local time zone (not the server time zone), and the system shall support the additional display of labels associated with different geographical time zones such as PST, EST, GMT, etc. The labels for time zones shall be customizable.
h. The system shall permit the routing and display of real time activity at any standard client machine. Activity shall be shown in a dedicated activity window that is updated automatically when new transactions occur. This option shall not be limited to routing transactions to one location and shall support the simultaneous routing and display of real time activity at multiple locations.
i. Alarms shall be capable of being routed to specific client machines by time of day or day of week.
j. Unacknowledged alarms shall be capable of being routed to alternate client or Email based on age and priority of alarm.
k. The display of reader door alarms shall be automatically enabled or disabled by the use of timed commands, either by reader or by a group of readers.
l. The system shall support a generic ASCII input capability that allows the system administrator to define specific ASCII input strings as alarms to be displayed in the alarm monitoring window as well as on the graphical map interface if so configured.

21. E-mail Alarms
    a. The SMS shall support the ability to automatically e-mail alarm condition messages.
    b. Each alarm definition shall allow a destination e-mail address to be defined. The e-mail address may be an address group as defined in the e-mail MAPI application.
    c. E-mail alarm messages shall be controlled by time of day and day of the week. For example, e-mail to the Facility Security Supervisor would only be generated when alarms occur during after-hours times.
22. Graphical Site Maps
    a. To further enhance the presentation to the operator, the system shall have the ability to import and use graphical maps. Maps shall be linked together using a tiered tree structure. To speed the location of an incident, each map level shall contain a clearly visible indicator as to which sub map the operator should select next to find the device that is in alarm.
    b. Maps shall also have the ability to be configured to appear automatically on presentation of a new alarm, providing the operator with prompt visual indication that an alarm has occurred.

c. The status of readers, doors, monitor points and auxiliary outputs shall be requested from any map by simply selecting the icon representing the device and its current state will be displayed.
d. The icons on the graphic map shall dynamically indicate the status of the device they represent. For example, a door icon shall change to show the door open when the door position sensor indicates such, and shall change to the original icon when the door is again secure. Additionally, monitor points shall also change to show their current state.
e. Should the operator wish to change the current setting, simply pressing the right mouse button shall cause the appropriate command options list to appear for selection.
f. Having selected a command, confirmation shall be provided by reflecting the change in status on the display.
g. Maps shall be created using standard office tools such as Paint® or drawing packages such as AutoCAD®. It shall be possible to import drawings in the following formats: JPEG, Bitmap, Windows metafile or DXF.
h. Icons representing access points, monitoring points, switching outputs, alarm inputs, CCTV cameras or intercom call stations shall be placed on any map at the required location in a drag and drop manner.
i. It shall be possible to define on the map the location of readers, access doors, alarm monitored points, output switching relays, CCTV cameras, Digital Video Recorder Cameras, Intercom call stations and alarm panel devices. The map display shall allow the operator to switch the video display of any defined CCTV camera to any defined CCTV monitor. The map display shall allow the display of stored and live Digital Video Clips.
j. It shall be possible to define on the map the location of reader groups and camera groups. Such groups shall be placed and appear as a single icon, but actions taken on them shall affect the entire group.
k. It shall also be possible to change the status of readers, reader groups, floor groups, alarm monitored points or output switching relays and confirm the successful execution of such commands from the map display. This functionality shall be capable of being restricted per device based on operator permission.
l. The map display shall include the option to display a group of similar devices as a single icon. Once devices are grouped it shall be possible to change their status. For example, it shall be possible to unlock all entrance doors by executing a single command from the map display.

23. Device Configuration
a. The system shall support a notes field to be associated with each device configured on the system. The notes field shall be free-form text, and shall support a minimum of 256 characters. The notes field may be used for detailed device descriptions or for maintenance history. The notes field shall also allow files to be associated.
b. The system shall provide a hierarchical tree view of the system configuration supporting expansion and collapse of any and all branches.

24. Windows Daylight Saving Auto Adjustment
    a. The system shall support Windows TimeSrv or Windows time management.
25. History Archive and System Back up
    a. The system shall allow on line archiving of history logs, along with database back up of system configuration and cardholder details. To further ease the burden of remembering to back up your system's database, this function shall be able to be automated to occur without intervention at a pre-set time.
    b. The system backup and history archive shall be to a destination drive and path located on a different PC accessible to the Database machine via the network.
26. The manufacturer of the SMS shall make available documentation on Server Hardening, which shall, at a minimum, detail the TCP/IP ports that are utilized by the system to allow other ports to be closed.

1.05 SUBMITTALS

A. Product Data

Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures
   1. Provide submittals to Eugene School District's Project Manager.
   2. Submit three (3) copies of each submittal.

C. Manufacturers Installation and Programming Instructions
   1. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

1.06 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.07 MAINTENANCE

A. Provide full procedures for all database back-ups.

B. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

B. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

C. Product Availability
   1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his proposed Contract Time.
   2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.

2.02 SMS and Intrusion Software

A. Software – Lenel OnGuard product set. Contractor shall integrate the security, intrusion, access systems to the existing Owner provided software.

B. Licensing – Lenel SMS. Owner to provide all required software licenses for a complete and functional system.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.

B. The Contractor must have been a factory authorized dealer with the proposed manufacturer for a period of at least two (2) years before the Bid Opening Date.

C. The Contractor's installers and technicians shall also be factory trained and certified to perform such tasks.

3.02 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.

3.03 POWER TO SECURITY EQUIPMENT

A. Power all equipment from 120 VAC circuit dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded "Security Equipment - Do Not Operate", or equivalent.

B. All plug-in transformers shall be located at the security control panels. Secure all low-voltage plug-in transformers to outlet with screw or strap. Clearly label all transformers to identify purpose and use.

3.04 INITIAL PROGRAMMING AND CONFIGURATION

A. Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Consultant and Owner to determine operating parameters.

B. Contractor shall develop and input system graphics, such as maps and standby screens. Owner shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings, in the form of AutoCAD® .DWG or .DXF files, as the basis for the creation of maps.

C. Owner, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.

D. Approximately sixty (60) days after start-up of system, Contractor shall return to project to provide follow-up assistance with system configuration as requested by Owner. Contractor shall include an allowance of forty (40) hours of labor for follow-up assistance in his Base Bid price.

END OF SECTION – 28 1316

ACCESS CONTROL INFRASTRUCTURE

PART 1 GENERAL REQUIREMENTS

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 RELATED SECTIONS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1313 Access Control Applications

C. 28 1316 Access Control Database Management

D. 28 1326 Access Control Remote Devices

E. 28 1333 Access Control Interfaces

F. 28 1343 Access Control ID Management

G. 28 1613 Intrusion Detection Panels

H. 28 1619 Intrusion Detection Remote Devices

I. 28 1633 Intrusion Detection Interfaces

1.02 SCOPE INCLUDES

A. Division 28 is responsible for installation of wiring to ancillary devices at the door including but not limited to; door contacts, card readers, request to exit sensor and magnetic strikes.

B. Division 28 is responsible for installation of wiring to door strike, lock down buttons, sirens, motion sensors, keypads and door contacts.

1.03 SYSTEM USER REQUIREMENTS

A. The SMS hardware wiring shall support all of the following options for supervision of the monitored input points:

B. 2-state supervision – in which only secured and alarm state are indicated

C. 3-state supervision – in which the input state can be secure, alarm or open circuit

D. 4-state supervision – supports secure, alarm, short circuit and open circuit states

1.04 ACCESS MONITORING & CONTROL SCHEDULES

A. See drawings for device locations and quantities.

1.05 SUBMITTALS

A. Product Data

Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures
   1. Provide submittals to Eugene School District's Project Manager.
   2. Submit three (3) copies of each submittal.
   3. Shop Drawings
   4. General Shop Drawings for the project as described elsewhere.
   5. Provide other Shop Drawings only if specifically requested by Eugene School District's Project Manager

1.06 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Eugene School District, or acts of god.

E. Contractor shall promptly respond to Eugene School District's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from Eugene School District, but in no case shall service response exceed 8 hours from time of request.

1.07 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

2.02 PRODUCT AVAILABILITY

A. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his proposed Contract Time.

B. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.

2.03 WIRE AND CABLE

C. Wiring by Division 28

1. Door controller to reader 4-pair 22AWG shielded or per manufacture instructions – Orange outer jacket
2. Door controller to electric lock 2-conductor 12AWG or per manufacture instructions – Orange outer jacket
3. Door controller to door status switch 4-conductor 22AWG or per manufacture instructions – Orange outer jacket
4. Door controller to request-to-exit where shown 2-pair 22AWG or per manufacture instructions – Orange outer jacket
5. Panel to power supply 2-conductor 16awg or per manufacture instructions – Orange outer jacket

D. Conduit and Raceway Systems

1. General: The placing of surface mounted conduit on the exterior of any building shall be approved by Eugene School District prior to its installation.
2. Interior Conduit:
   a. Electrical Metallic Tubing (EMT)
   b. Flexible Metal Conduit
   c. Provide fittings and connectors as required for installation of EMT or flexible conduit.

1. Surface Raceways:
   a. Sheet metal channel with fitted cover, suitable for use as surface metal raceway, Wiremold or approved equal.
   b. Provide fittings, elbows, and connectors designed for use with raceway system.
2. Exterior Conduit: (any of the following as determined by local code requirements):
   a. Rigid Steel Conduit
   b. Rigid Aluminum Conduit
   c. Rigid Nonmetallic Conduit (only if buried 18" below ground surface).
   d. Intermediate Metal Conduit
   e. Provide rain-tight fittings and connectors as required for installation of exterior conduit.
3. Exterior Flexible Conduit:
   a. Liquidtight Flexible Conduit: Flexible metal conduit with PVC jacket.
   b. Provide rain-tight fittings and connectors as required for installation of Liquidtight Flexible Conduit.
4. Junction and Pull Boxes
   a. Interior Boxes: Sheet Metal Outlet Boxes: Sizes to be determined in accordance with code requirements for conductor fill. No box shall be smaller than a single gang 1-1/2 deep. Provide box covers as required.
   b. Exterior Boxes: All exterior boxes shall NEMA 4 or NEMA 3R, watertight and dust-tight

c. All interior and exterior boxes shall have their covers fastened using security screws.

E. Lightning Protection

1. The Contractor shall provide suitable lightning protection for all processors/controllers.

2. All lightning protection equipment shall be UL listed.

PART 3 EXECUTION

3.01 WIRE AND CABLE

A. All wire and cable from the processors to all devices at each door shall be “home-run” unless otherwise specified.

B. All wire and cable, including any wire and cable that is existing and will be reused in the Work, shall be installed in conduit or surface metal raceway.

C. Wire or cable, in lengths of less than ten (10) feet, that is “fished” within walls, ceilings, and door frames.

D. All wire and cable passing thru metalwork shall be sleeved by an approved grommet or bushing.

E. All splices shall be made in junction boxes (except at equipment). Splices shall be made with an approved crimp connection. Wire nuts shall not be used on any low-voltage wiring.

F. Identify all wire and cable at terminations and at every junction box. Identification shall be made with an approved permanent label, Brady or equal.

3.02 WIRE AND CABLE TERMINATIONS

A. Identify all inputs and outputs on terminal strips with permanent marking labels.

B. Neatly dress and tie all wiring. The length of conductors within enclosures shall be sufficient to neatly train the conductor to the terminal point with no excess. Run all wire and cable parallel or normal to walls, floors and ground.

C. Install connectors as required by equipment manufacturers.

D. Terminations shall be made so that there is no bare conductor at the terminal. The conductor insulation shall bear against the terminal or connector shoulder.

E. Do not obstruct equipment controls or indicators with wire or cable. Route wire and cable away from heat producing components.

3.03 CONDUIT AND RACEWAY INSTALLATION

A. Design, lay-out, size and plan new conduit and raceway systems as required.

B. Indoor Requirements:

1. Route exposed conduit and raceway parallel and perpendicular to walls and adjacent piping.
2. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps.
3. Use conduit bodies to make sharp changes in direction, as around beams. Fasten conduits and raceways to structural steel using approved spring clips or clamps.
4. Where conduit penetrates fire-rated walls and floors, seal opening with UL listed fire rated sealer or other methods as approved by codes.
5. No exposed conduit, raceway, or junction box shall be installed within any office area.
6. Install all boxes straight and plumb.
7. Do not support conduit from mechanical, plumbing, or fire sprinkler systems.
8. Do not use flexible conduit in lengths longer than six (6) feet.

C. Outdoor Requirements:

1. Where conduit penetrates exterior walls, seal opening around conduit in an approved manner to make watertight
2. Use galvanized straps and fasteners on all exterior conduits.
3. All exterior boxes will only be used to aid in pulling the cable between points.

3.04 PENETRATIONS

A. Do not penetrate any roof, flashing, exterior wall, or parapet without prior approval from Eugene School District's designated Construction Project representative.

B. When penetrating a fire wall for passage of cables and/or conduit, always provide a fire-stop system that complies with code and the local authority having jurisdiction.

3.05 FIRE RATED DOORS AND FRAMES

A. Do nothing to modify a UL® rated door or frame that would void the UL® label or fire rating.

END OF SECTION 28 13 19

ACCESS CONTROL REMOTE DEVICES

PART 1 GENERAL REQUIREMENTS

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 SECTION INCLUDES

A. Field Panels

B. Cards & Readers

C. Keypads

D. Electric Locks, Strikes

E. Request-to-Exit Devices

1.03 RELATED SECTIONS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1313 Access Control Applications

C. 28 1316 Access Control Database Management

D. 28 1319 Access Control Infrastructure

E. 28 1333 Access Control Interfaces

F. 28 1343 Access Control ID Management

G. 28 1613 Intrusion Detection Panels

H. 28 1619 Intrusion Detection Remote Devices

I. 28 1633 Intrusion Detection Interfaces

1.04 SYSTEM USER REQUIREMENTS

1. Door lock release relays shall be minimally rated for 3 A @ 30 VDC.
2. Readers supporting various technologies shall provide data from card presentations through a door control unit (DCU) that includes the electrical interface to the reader and inputs for door sensors and form C relays for outputs.
3. Enclosures and Power Supplies
    1. All electronic circuits supplied, with the exception of the Single Door PoE Edge Network Controller, or those which are PoE powered or within a client or server or recorder PC, shall be mounted on standoffs inside the manufacturer-supplied enclosures. All such enclosures must include a key lock on a removable hinged door, and must include a tamper switch to detect when the door is opened. Systems without key locking of enclosure doors or without doors which are both hinged and removable shall not be acceptable.
    2. All electronic circuits supplied for the access control system, except those which are PoE powered or within a client or server or recorder PC, shall be powered by 18-20VAC through supplied 120VAC to 20VAC molded case, fully insulated isolating transformers. The transformer shall be mountable inside the supplied enclosure or separately. Systems which require 120VAC power to be brought directly to the enclosure shall not be acceptable.

1.05 ACCESS MONITORING & CONTROL SCHEDULES

A. See drawings for device locations and quantities. Coordinate door hardware with Division 8.

1.06 SUBMITTALS

A. Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Provide submittals to Eugene School District's Project Manager.

C. Submit three (3) copies of each submittal.

D. Shop Drawings

1. General Shop Drawings for the project as described elsewhere.
2. Provide other Shop Drawings only if specifically requested by Eugene School District's Project Manager.

E. Manufacturers Installation and Programming Instructions

F. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

1.07 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Eugene School District, or acts of God.

1.08 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.09 MAINTENANCE

A. Provide full procedures for maintaining physical and software firewalls.

B. Provide full procedures for testing battery condition on all field panels for adequate back-up time.

C. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his proposed Contract Time.

2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.

2.02 ACCESS CONTROL SYSTEM - SYSTEM SPECIFICATIONS

B. Card Readers

1. Lenel-Security Reader Interface – LNL-1300 for single door application, LNL-1320 for dual door application – Provide 1 per card access door indicated on the drawings.
2. Card Reader – HID Thinline II, 5395CG100.
3. Card Reader – HID MiniProx 5365, mullion mounted.
4. Card Reader – HID 5355AGN00 with HID 5455AGM00 glass mount kit.
5. Pin Pad – HID 5355AGK09 for Arm/Disarm.
6. Pin Pad – HID 5355ABK09 for door control.

C. Access Panels

1. Lenel- Enterprise Series

D. HID Proximity Series

1. Proxpro II

E. Proximity Cards

1. 1326 standard proximity cards
2. 1386 ISO series proximity cards
3. The Contractor shall provide 500 cards with the system.

F. Division 8 provided and installed equipment with final cabling connection by Division 28.

1. Electric Locks – Field verify requirements on a door by door basis
2. Electric strikes
    a. 12VDC Field Verify Manufacturer
3. Electric mortise locks
    a. 12VDC Field Verify Manufacturer
    b. 24VDC Field Verify Manufacturer
4. Electric hinges
    a. 12VDC Field Verify Manufacturer
    b. 24VDC Field Verify Manufacturer
5. Electric power transfers
    1. 12VDC Field Verify Manufacturer
    2. 24VDC Field Verify Manufacturer
6. Request-to-Exit Devices – Field Verify Requirements
7. Touch sense bars
8. Electronic push bars

PART 3 EXECUTION

1.01 COORDINATION WITH DIVISION 8

A. Contractor shall coordinate with the door hardware contractor prior to procurement of any door related electronic components.

1.02 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.
B. Outdoor Requirements:
C. Where conduit penetrates exterior walls, seal opening around conduit in an approved manner to make watertight
D. Use galvanized straps and fasteners on all exterior conduits.
E. All exterior boxes will only be used to aid in pulling the cable between points.

1.03 PENETRATIONS

A. Do not penetrate any roof, flashing, exterior wall, or parapet without prior approval from Eugene School District's designated Construction Project representative.

B. When penetrating a fire wall for passage of cables and/or conduit, always provide a fire-stop system that complies with code and the local authority having jurisdiction.

END OF SECTION 28 1326

ACCESS CONTROL INTERFACES

PART 1 GENERAL REQUIREMENTS

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 SECTION INCLUDES

A. Head-end Software

B. Field Panels

1.03 RELATED SECTIONS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1313 Access Control Applications

C. 28 1316 Access Control Database Management

D. 28 1319 Access Control Infrastructure

E. 28 1326 Access Control Remote Devices

F. 28 1343 Access Control ID Management

G. 28 1613 Intrusion Detection Panels

H. 28 1619 Intrusion Detection Remote Devices

I. 28 1633 Intrusion Detection Interfaces

1.04 SYSTEM USER REQUIREMENTS

A. Network Communications

1. The first field panel in a chain of panels shall have the ability to communicate with its monitoring client PC over the local or wide area network. This shall be achieved by the addition of a network interface c and provide a cost effective alternative configuration to a direct connection via a client PC's serial port. The network interface shall support both "10 base T" and "100 base TX" (10/100) communications speeds. The network interface shall support encryption utilizing AES algorithm.

2. A modem and telephone line shall be configured to provide an alternative path for the reporting of alarms in the case of unavailability of the network. The fallback to dial-up alarms reporting shall be automatic in the event of detecting a network communications failure.

B. Manual and Automatic Commands

1. Operators shall be provided with a wide choice of manual commands embracing the control of readers, monitor points, output switching relays and door locking devices. The operator shall have the ability to check the status of single, or multiple devices to ensure the operator is always able to check the operational status of the system and make adjustments as requirements change. When graphical maps are utilized, status requests shall be simply initiated by "clicking" on the device icon within the map. This functionality shall be capable of being restricted per device based on operator permission.

2. Automatic commands shall be included and may operate on a timed or event basis.

3. Scheduled commands shall easily be defined linking complimentary commands to occur at the start and stop times of any chosen timecode.

4. Event triggered commands shall provide an extremely powerful means of creating IF/THEN/WHEN associations encompassing a wide selection of IF conditions to the automatic execution of THEN commands subject to a WHEN timecode being active. A minimum of 10 THEN actions shall be available per trigger command.
5. The SMS shall support an unrestricted number of automatic (scheduled and trigger) and manual commands. These commands shall be capable of spanning across multiple field controllers.

C. Card Initiated Commands

1. The software shall allow authorized cardholders to initiate powerful trigger commands manually from selected reader locations when certain models of readers are used in conjunction with the field panels.
2. Up to 99 predefined commands shall be invoked by an authorized card allowing, for example, a patrolling guard to switch on outputs, disable monitor points, lock doors, providing remote management of the system during a patrol of the site.
3. The system shall only permit assigned users to enter command codes at keypad readers. Such assigned users shall not be restricted as to when or where they can enter a command code – such restrictions may be placed on the commands themselves.

D. Building Control Module Option

1. The system shall provide an option, the Building Control Module, to allow the definition of one or more building controls, each used to control a separate HVAC or other building system. Readers and/or motion detector inputs shall be used to determine the occupancy of the area represented by the building control.
2. The Building Control Module shall support BACnet communications. The module shall use the BACnet communications protocol to project current status of building controls, monitor points, doors and the last alarm generated to third-party building systems.
3. The system shall allow manual commands to interface with building controls through the BACnet protocol. It shall be possible to issue these commands from on-screen graphical maps or plans of the building.
4. The system shall allow scheduled commands to interface with (turn on or off) building controls through the BACnet protocol. It shall be possible to issue these commands automatically at any time of the day, any day of the week or holiday dates.
5. It shall be possible to view the current status of a building control from the View/Status screen in the SMS software.
6. The system shall allow the definition of groups of building controls, which enables, for example, a single command to switch on several building controls in one operation.

E. Dial-In/Out Alarms Option

1. The SMS shall support a dial-out (alarm transmission) alarms reporting capability. A complimentary dial-in (alarm receipt) capability shall also be supported. This option would be used, for example, when an alarms monitoring client is unmanned outside of normal office hours and alarms generated at these times to be copied to a central manned system located elsewhere not on the LAN/WAN.
2. The alarm messages copied to the alarms-receiving (dial-in) site shall be the same as those displayed at the local (dial-out) site. However, the alarm instructions (as displayed when acknowledging an alarm) may be different.

F. Intrusion Detection System Integration Option

1. The SMS shall support a high-level integration to an Intrusion Detection System (IDS). The SMS shall support events to be recorded and displayed from the IDS system on the alarm management screen and in the transaction history reports.
2. The integration to the IDS shall support, at a minimum, secondary monitoring of all IDS alarm transactions while allowing it to still be monitored by a central station, if desired.
3. The IDS integration shall also include the ability to arm and disarm the IDS from the SMS user interface. This feature must be available with all IDS products.
4. IDS alarms shall be capable of triggering a series of SMS events. For instance, when the IDS reports that the system was armed, the SMS shall be able to lock all doors.
5. IDS alarms shall be viewable on the SMS map interface.
6. The communication with the IDS control panel shall be monitored, and the SMS shall produce an alarm in the event of a communications failure.
7. The SMS must provide integration with both the DMP communication with the IDS control panel shall be monitored, and the SMS shall produce an alarm in the event of a communications failure.

1.01 SUBMITTALS

A. Product Data

Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures

1. Provide submittals to Eugene School District's Project Manager.
2. Submit three (3) copies of each submittal.

C. Manufacturers Installation and Programming Instructions

Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Security of Contractor's Tools and Equipment: Eugene School District is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

1.03 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Eugene School District, or acts of God.

E. Contractor shall promptly respond to Eugene School District's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from Eugene School District, but in no case shall service response exceed 8 hours from time of request.

1.04 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

1. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.

E. See Section 281316 Part 2 for software requirements.

F. See Section 281326 Part 2 for hardware requirements.

PART 3 EXECUTION

3.01 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation.

B. Bench test per manufacturer's installation instructions.

3.02 INITIAL PROGRAMMING AND CONFIGURATION

A. Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Consultant and Owner to determine operating parameters.

B. Contractor shall develop and input system graphics, such as maps and standby screens. Owner shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings, in the form of AutoCAD® .DWG or .DXF files, as the basis for the creation of maps.

C. Owner, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.

D. Contractor shall maintain hard copy worksheets which fully document the system program and configuration. Worksheets shall be kept up to date on a daily basis by Contractor until final Acceptance by Owner. Worksheets shall be subject to inspection and approval by Owner. Provide final copies to Owner prior to Project Close-out.

E. Approximately sixty (60) days after start-up of system, Contractor shall return to project to provide follow-up assistance with system configuration as requested by Owner. Contractor shall include an allowance of forty (40) hours of labor for follow-up assistance in his Base Bid price.

END OF SECTION 28 13 33

ACCESS CONTROL IDENTIFICATION MANAGEMENT SYSTEMS

PART 1 GENERAL REQUIREMENTS

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 SECTION INCLUDES

A. Head-end Hardware and Software

B. Field Panels

C. Cards & Readers

D. Electric Locks, by Division 8

E. Request-to-Exit Devices

F. Wiring

1.03 RELATED WORK BY OTHERS

A. All required category 6a rough-in cabling to support the system will be provided as 27 1500 – Communications Horizontal Cabling

1.03 RELATED SECTIONS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1313 Access Control Applications

C. 28 1316 Access Control Database Management

D. 28 1319 Access Control Infrastructure

E. 28 1326 Access Control Remote Devices

F. 28 1333 Access Control Interfaces

G. 28 1613 Intrusion Detection Panels

H. 28 1619 Intrusion Detection Remote Devices

I. 28 1633 Intrusion Detection Interfaces

1.04 SYSTEM USER REQUIREMENTS

A. Video Imaging

1. The system shall incorporate video imaging as a fully integrated function to customize access control cards by printing an identity badge directly onto the card. The badge design and image capture capabilities shall combine with the latest technology card printers to allow the production of an ID badge pass for each card holder at the time of registration.

2. For each cardholder both a facial image and a signature shall be able to be captured, or imported, and stored as part of the card record. These images shall be captured from a standard CCTV camera connected to the computer via a Video Card supporting DirectX 10 (or later) or MCI format, or imported if available as a bit map or JPEG file. The system shall use data compression techniques to ensure efficient use of the available hard disk space to maximize the number of images that can be stored on the hard disk.
3. System shall provide the ability to crop the image (live capture or imported from JPG, BMP, or WMF) to the desired area maintaining the proper aspect ratio.

B. Badge Design and Printing

1. A comprehensive integrated badge design facility shall also be provided, allowing an unrestricted number of custom badge layouts to be defined then saved with a suitable description as a reference. This shall make full use of the card record details such as name, card number, inactive date as well as allowing personal data to be included in the badge design. Company logos shall be imported as bitmaps (BMP) or JPEG images to provide a personalized corporate appearance to the card.
2. All elements incorporated into the design shall be able to be rotated.
3. When creating a new card record a badge preview screen shall also be included that displays the specific card's details on the selected badge design to allow confirmation prior to requesting the badge to be printed.
4. Each new cardholder record shall have the option to be flagged for future printing. Cards flagged in this manner shall be easily recalled at a later stage and processed for output to the printer in a single action. Selecting multiple cards for bulk printing shall also allow each card to be printed either with its specific badge design, as defined within each card's record, or alternatively printed with a selected common badge design. Encoding of magnetic stripe cards shall also be included as part of the bulk printing process.
5. The SMS shall support any manufacturer's ID badge printer with a Windows compatible printer driver.
6. The SMS shall provide the option to encode a proximity card during the print cycle shall also be incorporated. Applications that require on-site encoding can combine both actions in a single process. Encoding may only be supported on a limited set of printer models defined by the SMS manufacturer.
7. Each badge design shall include a default printer, validity period, and access rights.
8. Objects (images, or other fields to be printed to the card) shall support the ability to be enabled or disabled by the presence of a specific label in the cardholder record. For instance, a logo indicating certain training would be printed only if the personal data field identified indicated such a certification for that cardholder. Solutions requiring a separate badge design for any change in badge graphical content shall not be acceptable.

C. Video Verification

1. The Video Imaging option shall also provide a monitoring screen that will automatically display the stored image for a card when used at a reader. This screen shall operate in conjunction with a live video input from a CCTV camera viewing the selected access point, allowing the operator to verify that each card offered is in fact being used by the person to whom it was issued.
2. This screen shall also be frozen and printed to provide a hard copy evidence of any abuse observed by the operator. For high security access points, the system shall be configured to not grant access until the operator has verified the stored and live images are the same person, with the door release being controlled by the system operator.
3. Video verification shall include the ability to monitor at least 4 portals on the same screen (for application with turnstiles, for example). This feature shall also provide the operator with a means of granting access to the individual with a single mouse click.

D. Report Generation

1. Extensive history reporting shall be a standard integrated feature; and shall include the ability to review all system alarms, access control activity, and operator actions. These reports shall be made available for review via the operator's display screen, or to a printer, or to another disk media. Extensive sort parameters shall include by any of the "Personal Details" fields or Titles, for example by "Department", and only Names commencing with "SM*".
2. The system shall support generation of reports detailing the system operation. The following reports shall be available in the software:
    a. Cards on site
    b. Hours on site
    c. Cardholders with access to each door
    d. Access rights of each cardholder
    e. System Configuration
    f. Scheduled and Conditional Commands defined
    g. System operator transaction history
3. It shall be possible to replay video clips associated with events by directly interacting with the report as published to the computer screen.
4. The system shall demonstrate the ability to export data, for example reports, to other standard office word processing packages such as Microsoft Word®.
5. The system shall provide system management reporting, including detailed listings for all the operator actions and the current cardholder database for output to the display screen, printer or disk media.
6. The system shall have the ability to save frequently used report configurations and associate them with a "Title". Such predefined reports shall be available from a list to simplify the report selection. It shall be possible to request these reports to run immediately or schedule them to occur at a specified date and time.

7. Scheduled reports shall additionally have the option to be automatically repeated by specifying the number of days and reporting period to be included, for example a weekly report of Alarms to run at 10:30 am each Monday and including the previous 7 days of Alarms.
8. The system shall allow custom reporting options by providing an interface to a commercially available 'off the shelf' reporting product. The interface shall present all database fields in a structured format, which does not require detailed knowledge of the database design and table relationships.
9. History Reporting
    a. Extensive reporting shall be included to provide the ability to review all system alarms, access control activity and operator actions. These reports shall be available for review on the operator's display, to a printer, or to a file.
    b. Frequently run report configurations shall be saved allowing them to be selected and run on demand, or scheduled to run automatically as required. When scheduled to run automatically this shall have the ability to be repeated.
10. Cards On-Site Reporting
    a. This report shall provide a list of cardholders currently on the site. This may be for all persons within the site or just who, for a particular department or a particular contractor company, is currently present. The report may also be run to cover just a part of the site, for example, cardholders in a particular building or room.
11. Report Auditing/Archiving
    a. The SMS shall have the option to automatically and without user intervention keep a separate archival copy of each generated report, whether the report is sent to screen, printer, or file. The archival copy must be generated at the time of each request and stored unmodified thenceforth. Systems that attempt to reconstruct the archival copy only when it is requested are not acceptable.
12. Addition of Cardholders to the System Database
    a. The system shall provide a means of assigning access control rights to each cardholder. Access control rights determine which access points are accessible to the cardholder based on date and time of day. The system shall support an unrestricted number of access rights.
    b. Each cardholder shall either be associated with standard door timings, for door release, door open and door pre-held or be given extended timings for disabled persons or someone who has to push a cart.
    c. Cardholders who have not used a reader for some time shall be readily listed to allow their card's status to be reviewed. An additional feature shall allow cardholders to be automatically set inactive and therefore access denied should the card have not been presented at any reader on the system for a defined number of days.

d. Cardholders shall be assigned an expiration date, and more specifically an expiry time, after which a card shall automatically become inactive and therefore be rejected at all readers on the system. To further simplify card administration, the system shall have the ability to be configured to automatically purge expired cardholder records after a configurable number of days from the date of expiration.

e. The system shall allow for the definition of Access control rights to be associated with a badge design. Each user that selects that badge design shall be provided with the associated access control rights that can further be customized for the specific cardholder.

f. The system shall allow access control rights to be defined for a cardholder on a reader group basis. Reader groups are groups of readers. A time code will be associated with each reader group as it is assigned to the cardholder's access control rights.

g. The system shall allow access control rights to be defined for a cardholder on an access code basis. An access code is a group of access control rights.

h. The system shall have a note field associated with each cardholder record. The note field shall be free form text and shall support a minimum of 256 characters. The note field shall further support the ability to attach a file (of any type or size) to the cardholder record.

i. When viewing a cardholder record the last twenty-five (25) valid door access transactions shall be displayed to help locate a cardholder.

j. The system shall support a field for assigning an approving official to the cardholder record that defines the individual who authorized the assignment of a credential. Approving officials shall have an associated validity period and image of their signature. As an option, the assignment of an approving official shall be mandatory.

13. Cardholder Details

a. Cardholder information shall include first and last name, card number, PIN code and valid period to provide automatic expiration. Each cardholder record shall also incorporate at least 50 user-defined personal data fields, independent of user-defined fields for visitor management.

b. Data entry shall be simplified by remembering previous entries of personal data and allowing selection from a pick list to minimize repetitive typing when creating each cardholder's record. The cardholder database and the history log shall also be sorted by any of the additional fields of information making them a powerful tool for filtering data.

c. Personal data fields shall support free entry text, picking an entry from a previously configured list, or picking an entry from an updatable list. Each of these entries shall further be categorized as a date, a time, general input, or customized input. Each category shall support the masking of input data to assure data integrity. For instance, a date mask might look like "mm/dd/yyyy" to indicate that the date input should be a two-digit month followed by a two-digit day followed by a four-digit year all separated by the slash character. The mask shall be required for customized input.

d. Personal data fields shall have the option of being configured as mandatory.

14. Card Watch Feature

a. Any cardholder shall be easily tracked as they move around a large site by selecting card watch. As the person uses their access control card, the system shall have the ability to automatically notify the operator of the person's presence at each location.

15. Key Card Mode

a. Key card mode authority shall be assigned to special cardholders, such as site key holders, and can be enabled on a per reader basis. This shall allow a person when vacating an area or building to change the reader's mode of operation from normal access control to Key Card Out operation.

b. When in this condition only persons with key card privileges shall gain access through the door, all non-key card users are rejected regardless of their card's current access rights.

c. This special feature shall be activated / deactivated by the key cardholder, using a card swipe followed by a special code entered via the reader's keypad.

16. Visitor management

a. Visitor Management shall be incorporated as a standard feature of software. Operators shall be able to pre-enroll visitors using a Web (thin) or Standard (thick) client. The thin client shall connect to the server via Microsoft™ Terminal Services and Microsoft™ Internet Explorer to permit any operator with visitor permissions assigned the ability to pre-enroll visitors without the need to install client software on their local machine.

b. Visitor Management shall be fully integrated with other key areas of the system, such as access, alarms management, muster and Video ID Badging. Visitor records shall have 50 personal data fields with user definable data titles independent from the personal data fields defined for cardholders. All visitor transactions and movements shall be recorded and may be reported on and filtered, using the extensive reporting capabilities of the software. Visitors may exist without being assigned a card number if access control is not required.

c. Data entry shall be simplified by remembering previous entries of personal data and allowing selection from a pick list to minimize repetitive typing when creating each visitor's record. The cardholder database and the history log shall also be sorted by any of the additional fields of information making them a powerful tool for filtering data.

d. Visitor time of arrival and time of departure shall be tracked by the system. This feature shall be available even if a visitor is not issued a card or card number in the system.

e. The SMS shall support capture of a business card image.

f. The SMS shall support the inclusion of a custom message for each visitor record.

g.

1.05 SUBMITTALS

A. Product Data

Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures

1. Provide submittals to Eugene School District's Project Manager.
2. Submit three (3) copies of each submittal.

C. Shop Drawings

1. General Shop Drawings for the project as described elsewhere.
2. Provide other Shop Drawings only if specifically requested by Eugene School District's Project Manager.

D. Manufacturers Installation and Programming Instructions

Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Security of Contractor's Tools and Equipment: Eugene School District is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

1.07 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.08 MAINTENANCE

A. Provide full procedures for all database back-ups.

B. Provide full procedures for upgrading software.

C. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his proposed Contract Time.

2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.

E. See Section 281316 Part 2.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.

B. The Contractor must have been a factory authorized dealer with the proposed manufacturer for a period of at least two (2) years before the Bid Opening Date.

C. The Contractor's installers and technicians shall also be factory trained and certified to perform such tasks.

3.02 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test equipment per manufacturer's installation instructions.

3.03 FIELD QUALITY CONTROL

A. Upon reaching Substantial Completion, perform a complete test and inspection of the system. If found to be installed and operating properly, notify Eugene School District of your readiness to perform the formal Test & Inspection of the complete system.

B. Submit the Record Drawings (as-builts) to Eugene School District for review prior to inspection.

C. During the formal Test & Inspection (Commissioning) of the system, have personnel available with tools and equipment to remove devices from their mounts to inspect wiring connections. Provide wiring diagrams and labeling charts to properly identify all wiring.

D. If corrections are needed, the Contractor will be provided with a Punch-List of all discrepancies. Perform the needed corrections in a timely fashion.

E. Notify Eugene School District when ready to perform a re-inspection of the installation.

3.04 INITIAL PROGRAMMING AND CONFIGURATION

A. Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Consultant and Owner to determine operating parameters.

B. Contractor shall develop and input system graphics, such as maps and standby screens. Owner shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings, in the form of AutoCAD® .DWG or .DXF files, as the basis for the creation of maps.

C. Owner, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.

3.05 MANUFACTURER PROFESSIONAL SERVICES

A. Contractor shall coordinate with the manufacturer to provide the manufacturer's professional services team to assist the Owner in coordinating the interfaces between the security management system and other on-site systems as necessary.

B. Professional Services personnel shall be employed by the manufacturer of the security management system and shall be thoroughly knowledgeable of the security management system applications.

C. Professional Services personnel shall be on-site and available to meet with Owner's representatives for a period of not less than two consecutive days. On-site visit shall be scheduled at the convenience of the Owner.

END OF SECTION 28 1343

INTRUSION DETECTION CONTROL PANELS

PART 1 GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. Head-end Hardware and Software

B. Field Panels

1.02 RELATED WORK BY OTHERS

A. All rough-in category 6a data cabling to support the system will be provided by Division 27 – Communications Horizontal Cabling where noted.

1.03 RELATED REQUIREMENTS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1313 Access Control Applications

C. 28 1316 Access Control Database Management

D. 28 1319 Access Control Infrastructure

E. 28 1326 Access Control Remote Devices

F. 28 1343 Access Control ID Management

G. 28 1619 Intrusion Detection Remote Devices

H. 28 1633 Intrusion Detection Interfaces

1.04 SYSTEM USER REQUIREMENTS

A. System Overview

1. The contractor shall provide and install a new integrated security management system that shall provide a simple and easy-to-use graphical user interface. The system shall provide local operational control of all access points and alarm sensors.

2. The system shall meet the requirements of UL®-294.

3. The manufacturer of the proposed system shall have been producing access control products for at least 10 years and shall be ISO 9000 and 9001 certified.

4. The manufacturer shall be a Microsoft Certified Gold Partner. System shall meet Microsoft requirements for “Designed for Microsoft Windows Server 2008, 2011 32 and 64 bit” and “Designed for Windows 7”, or “Windows 8”.

5. The manufacturer of the proposed system shall require resellers to pass a formal training program prior to being certified as authorized to sell and install the system. Such certification shall require annual re-qualification. The system integrator proposing the system shall be in possession of such a certification.

6. User Code Mode

   a. The Security Management Software, SMS shall support the ability to put a keypad-equipped reader into User Code Mode. This feature shall allow a cardholder to gain access by entering a valid card’s number at a reader keypad, therefore not requiring the holder to carry a card.

   b. User code mode shall be enabled on a per reader basis.

7. Data Connect Option

   a. The system shall provide an option to import and/or export both cardholder details (including facial images and signatures) and system alarm information to/from an external source. This option may be used to speed initial commissioning of the security management system's database, or in some cases, to allow synchronization with other employee management systems. This option may also be used to pass common data to other employee-related systems or databases. It shall be possible to manually start or schedule the data import. It shall also be possible to start the data import process from an external application, thus providing the means for real time import.

   b. The interface requirements shall be fully defined and support either a comma delimited ASCII text file or a Microsoft SQL® database import mechanism. Fully detailed supporting documentation shall be provided to enable a third party to design and implement this facility without needing reference to the system's manufacturer.

   c. Imported data shall reside in an intermediary table within the database until an integrity check can be applied to the data. Only after satisfying this test will data be included in the SMS data tables.

1.05 SUBMITTALS

A. Submittals shall be as per 28 0500.

1.06 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.07 MAINTENANCE

A. Provide full procedures for upgrading software.

B. Provide full procedures for testing battery condition on all field panels for adequate back-up time.

C. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

   1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into their proposed Contract Time.

   2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify their ability to procure the products specified prior to submitting a proposal.

2.02 INTRUSION DETECTION SYSTEM - SYSTEM SPECIFICATIONS

A. Security Panel – DMP XR550DNL-G equipped with;
   1. Metal Enclosure, provide as required for access/security components.
   2. Model 332 18VDC Transformer, provide 1 per panel

B. Zone Expanders – as required
   1. DMP-714-18T – Four zone.
   2. DMP-714-8 – Eight Zone
   3. DMP-714-16 – Sixteen Zone

C. Dialer – DMP 893 Dual Phone Module

D. Relay Module – DMP 860

E. Zone Output Module – DMP 716

F. Software – Lenel OnGuard product set. No Substitutions.
   1. See Section 28 1316 part 2.
   2. See Section 28 1326 Part 2.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.

B. The Contractor must have been a factory authorized dealer with the proposed manufacturer for a period of at least two (2) years before the Bid Opening Date.

C. The Contractor's installers and technicians shall also be factory trained and certified to perform such tasks.

3.02 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.

3.03 INITIAL PROGRAMMING AND CONFIGURATION

A. Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Consultant and Owner to determine operating parameters.

B. Contractor shall develop and input system graphics, such as maps and standby screens. Owner shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings, in the form of AutoCAD® .DWG or .DXF files, as the basis for the creation of maps.

C. Owner, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.

D. Contractor shall maintain hard copy worksheets which fully document the system program and configuration. Worksheets shall be kept updated daily until final Acceptance by Owner. Worksheets shall be subject to inspection and approval by Owner. Provide final copies to Owner prior to Project Close-out.

E. Contractor shall maintain a complete, up-to-date magnetic tape backup of the system configuration and cardholder database. Backup shall be maintained throughout programming period until final Acceptance by Owner. Submit back-up data in electronic format to the Owner upon Final Acceptance.

F. Approximately sixty (60) days after start-up of system, Contractor shall return to project to provide follow-up assistance with system configuration as requested by Owner. Contractor shall include an allowance of forty (40) hours of labor for follow-up assistance in their Base Bid price.

END OF SECTION 28 1613

INTRUSION DETECTION REMOTE DEVICES

PART 1 GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. Motion Sensors

B. Duress Buttons

C. Door Position Sensors

D. Wiring

1.02 RELATED WORK BY OTHERS

A. All related category 6a rough-in data cabling to support the system will be provided by Division 27.

B. All siren, sensor, door, cardreader, keypad cable and non-category 6a cable as required shall be installed by Division 28.

C. ADA push buttons will be installed by Division 8, coordinate final connection in the field.

1.03 RELATED REQUIREMENTS

A. 28 0500 Common Work Results for Access and Security

B. 28 1613 Intrusion Detection Panels

C. 28 1633 Intrusion Detection Interfaces

1.04 INTENT AND CORRELATION

A. The intent of the Project Drawings and Specifications is to include all items necessary for the proper execution and completion of the Work.

B. The Project Drawings and Specifications are complementary, and what is required by any one shall be as binding as if required by both.

1.05 REFERENCES

A. Submit the names and phone numbers of customers for at least three other projects of similar size and complexity using similar technologies.

1.06 SUBMITTALS

A. Product Data

Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures

1. Provide submittals to Eugene School District's Project Manager.
2. Submit three (3) copies of each submittal.

C. Shop Drawings

1. General Shop Drawings for the project as described elsewhere.
2. Provide other Shop Drawings only if specifically requested by Eugene School District's Project Manager.

1.07 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.08 MAINTENANCE

A. Provide full procedures for all database back-ups.

B. Provide full procedures for upgrading software.

C. Provide full procedures for testing battery condition on all field panels for adequate back-up time.

D. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into their proposed Contract Time.

2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify their ability to procure the products specified prior to submitting a proposal.

2.02 INTRUSION CONTROL SYSTEM

A. Keypads

1. DMP Keypad – White model 7063

B. Motion Sensors

1. Bosch DS970 or approved equal for wall mounted applications.

2. Bosch B328 gimbal mount bracket.

3. Bosch DS 9360 or approved equal for ceiling mounted applications.

C. Siren

1. Ademco 747.

D. Power Supply – Altronix AL1012ULX with PD4CB Distribution module

E. Door Contacts

1. Standard doors - Aritech 1078CW Series or approved equal

2. Storefront doors – Aritech 1840

3. Surface mount - Aritech 2505-L Series or approved equal

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.

B. The Contractor must have been a factory authorized dealer with the proposed manufacturer for a period of at least two (2) years before the Bid Opening Date.

C. The Contractor’s installers and technicians shall also be factory trained and certified to perform such tasks.

3.02 EXAMINATION

A. The Contractor shall be required to visit the installation site prior to bidding the

job.

B. The Contractor shall report any discrepancies between the Specifications, Drawings, and Site Examination prior to the Bid Opening Date.

3.03 PREPARATION

A. The Contractor shall order all required parts and equipment upon notification of award of the Work.

B. The Contractor shall bench test all equipment prior to delivery to the job site.

C. The Contractor shall verify the availability of power where required. If a new source of power is required, a licensed electrician shall be used to install it.

D. The Contractor shall arrange for obtaining all programming information including access times, free access times, door groups, operator levels, etc.

3.04 INSTALLATION

A. The Contractor shall coordinate with the Eugene School District's IT Department when connecting to their network.

B. The Contractor shall carefully follow the instructions in the manufacturers' Installation Manual to insure all steps have been taken to provide a reliable, easy to operate system.

C. The Administrator Terminal shall be connected to the remote terminals before connecting to any card reader processors.

D. The Contractor shall coordinate Division 8 for door strike and ADA functionality requirements.

E. Perform all Work as indicated in the Drawings and Specifications.

F. The Contractor shall install the appropriate cable from the CPU to readers, door contacts, request-to-exit devices, and electric locks at each door and/or gate.

G. All communications cables shall be kept away from power circuits.

H. The Contractor shall install the power supply(s) for electric locks in locations where they won't interfere with other operations.

I. The Contractor shall also execute adequate testing of the system to insure proper operation.

J. The Contractor shall provide adequate training of the system users to insure adequate understanding to prevent operating errors.

3.05 WORKMANSHIP

A. Comply with highest industry standards, except when specified requirements indicate more rigid standards or more precise workmanship.

B. Perform Work with persons experienced and qualified to produce workmanship specified.

C. Maintain quality control over suppliers and Subcontractors.

D. Quality of workmanship is considered important. Eugene School District Project Manager will have the authority to reject Work which does not conform to the Drawings and Specifications.

3.06 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench testing shall be per manufacturer's installation instructions.

3.07 GROUNDING

A. Provide earth-grounding of equipment as required by equipment manufacturer. Earth ground shall be connected to ground rod or approved cold water pipe. Electrical or telephone ground connections shall not be used as earth grounds. Connections to mounting posts or building structural steel shall not be used as earth grounds.

3.08 POWER TO SECURITY EQUIPMENT

A. Power all equipment from 120 VAC circuit dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded “Security Equipment - Do Not Operate”, or equivalent.

B. All plug-in transformers shall be located at the security control panels. Secure all low-voltage plug-in transformers to outlet with screw or strap. Clearly label all transformers to identify purpose and use.

3.09 CUTTING AND PATCHING

A. The Contractor shall be responsible for all cutting, fitting or patching that may be required to complete the Work.

3.10 FIELD QUALITY CONTROL

A. Upon reaching Substantial Completion, perform a complete test and inspection of the system. If found to be installed and operating properly, notify Eugene School District of your readiness to perform the formal Test & Inspection of the complete system.

B. Submit the Record Drawings (as-builts) to Eugene School District for review prior to inspection.

C. During the formal Test & Inspection (Commissioning) of the system, have personnel available with tools and equipment to remove devices from their mounts to inspect wiring connections. Provide wiring diagrams and labeling charts to properly identify all wiring.

D. If corrections are needed, the Contractor will be provided with a Punch-List of all discrepancies. Perform the needed corrections in a timely fashion.

E. Notify Eugene School District when ready to perform a re-inspection of the installation.

END OF SECTION 28 1619

INTRUSION DETECTION INTERFACES

PART 1 GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. Intrusion Detection Management Software (IDS)

B. Field Panels

1.02 RELATED WORK BY OTHERS

A. All rough-in category 6a data cabling to support the system will be provided by Division 27 – Refer to drawings for specific locations.

1.03 RELATED REQUIREMENTS

A. 28 0500 Common Work Results for Safety and Security

B. 28 1316 Access Control Database Management

C. 28 1319 Access Control Infrastructure

D. 28 1326 Access Control Remote Devices

E. 28 1333 Access Control Interfaces

F. 28 1343 Access Control ID Management

G. 28 1613 Intrusion Detection Panels

H. 28 1619 Intrusion Detection Remote Devices

1.04 SYSTEM USER REQUIREMENTS

A. System Partitioning

1. The access point readers, monitor points, and auxiliary outputs shall be managed on a partition basis by simply defining which devices are to be included in a partition.
2. The IDS shall be supplied with the ability to manage up to 64 partitions, and shall have an option to manage up to 999 partitions.
3. Operator permissions shall be created and assigned globally or by the Owner. When created and assigned globally an Operator's password shall be associated with one or more companies.

B. Alarm Management

1. Alarm handling shall be managed with up to 99 priority levels and user definable instruction messages to ensure the operator monitoring the site takes appropriate responses. The facility shall have the ability to customize audible alerts for each type of alarm is provided using standard or custom generated multimedia wave files. Each alarm type shall also be presented in a user-defined color.

C. E-mail Alarms

1. The IDS shall automatically e-mail alarm condition messages.
2. Each alarm definition shall allow a destination e-mail address to be defined. The e-mail address may be an address group as defined in the e-mail MAPI application.
3. E-mail alarm messages shall be controlled by time of day and day of the week. For example, e-mail to the Facility Security Supervisor would only be generated when alarms occur during after-hours times.

D. User Code Mode

1. The IDS shall support the ability to put a keypad-equipped reader into User Code Mode. This feature shall allow a cardholder to gain access by entering a valid card's number at a reader keypad, therefore not requiring the holder to carry a card.
2. User code mode shall be enabled on a per reader basis.
3. This mode shall support card number only, or card number and its assigned PIN code.

E. Dial-In/Out Alarms Option

1. The IDS shall support a dial-out (alarm transmission) alarms reporting capability. A complimentary dial-in (alarm receipt) capability shall also be supported. This option would be used, for example, when an alarms monitoring client is unmanned outside of normal office hours and alarms generated at these times to be copied to a central manned system located elsewhere not on the LAN/WAN.
2. The alarm messages copied to the alarms-receiving (dial-in) site shall be the same as those displayed at the local (dial-out) site. However, the alarm instructions (as displayed when acknowledging an alarm) may be different.

F. Intrusion Detection System Integration Option

1. The IDS shall support a high-level integration to an intrusion detection system (IDS). The third-party IDS shall be UL 1076 listed. The IMS shall support events to be recorded and displayed from the IDS system on the alarm management screen and in the transaction history reports.
2. The integration to the IDS shall support, at a minimum, secondary monitoring of all IDS alarm transactions while allowing it to still be monitored by a central station, if desired.
3. The IDS integration shall also include the ability to arm and disarm the IDS from the IMS user interface. This feature must be available with all IDS products.
4. IDS alarms shall be capable of triggering a series of IMS events. For instance, when the IDS reports that the system was armed, the IMS shall be able to lock all doors.
5. IDS alarms shall be viewable on the IMS map interface.
6. Lockdown function shall integrate with the IDS, Mass Notification and Integrated Communications System.
7. The communication with the IDS control panel shall be monitored, and the IMS shall produce an alarm in the event of a communications failure.
8. The IMS must provide integration with both the DMP communication with the IDS control panel shall be monitored, and the IMS shall produce an alarm in the event of a communications failure.

G. Thin Client Access Option

1. The system shall provide for an option of thin client access to the IMS. The thin client interface shall utilize Microsoft Terminal Services to provide the same look and feel of the thick client to minimize training time and expense. The thin client shall be capable of the same functionality of a thick client with the exception of functionality that requires access to ports on the thin client computer.

1.05 SUBMITTALS

A. Submittals shall be as per 28 0500

1.06 WARRANTY

A. Contractor warrants that all Work furnished under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Eugene School District, or acts of God.

1.07 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.08 MAINTENANCE

A. Provide full procedures for upgrading software.

B. Provide full procedures for testing battery condition on all field panels for adequate back-up time.

C. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.01 GENERAL

A. All products not provided by Eugene School District shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into their proposed Contract Time.

2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify their ability to procure the products specified prior to submitting a proposal.

E. Products

1. Intrusion detection panel interface fully compatible with the Security Management Software

a. Lenel Enterprise Series, DMP XR550DNL-G.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.

B. The Contractor must have been a factory authorized dealer with the proposed manufacturer for a period of at least two (2) years before the Bid Opening Date.

C. The Contractor's installers and technicians shall also be factory trained and certified to perform such tasks.

3.02 EXAMINATION

A. The Contractor shall be required to visit the installation site prior to bidding the job.

B. The Contractor shall report any discrepancies between the Specifications, Drawings, and Site Examination prior to the Bid Opening Date.

3.03 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench testing shall be per manufacturer's installation instructions.

END OF SECTION – 28 1633

FIRE DETECTION AND COMMUNICATIONS

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 provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:
   1. Replacing and expanding the existing facility fire alarm system.
   2. Design, install, and provide all labor, materials, and equipment required for a complete and operating system of manual and automatic initiating devices, audio/visual annunciation, voice communication with control panels, amplifier(s), speakers, auxiliary relays, power supplies, batteries and all accessories necessary to accomplish the desired sequence of events.
   3. The system shall be fully electronic and addressable as described below with monitoring and annunciation of all system alarms and troubles.
   4. Provide Fire Command Center and Fireman's Communication System.
   5. Provide Equipment Status and Control Panels.
   6. Interface each system with the attached adjacent building fire alarm system.

B. Related Sections include:
   1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables
   2. Section 26 05 33 Raceways and Boxes for Electrical Systems
   3. Section 26 05 53 Identification for Electrical Systems

C. This Section calls for design-build work. Provide a complete working fire detection and communications system as specified and as required by applicable codes. Contractor shall be responsible for producing design drawings, coordinating with the project Architect, and submittal to AHJ for approval and permit.

1.3 QUALITY ASSURANCE

A. Equipment shall be approved and installed in accordance with NFPA, ADA and IBC requirements and shall be UL listed both in individual components and as a system. All equipment shall be ISO-9000 certified; UL & FM listed and meet NFPA 72.

B. The system supplier shall furnish evidence that there is an experienced and efficient service organization which carries a stock of repair parts for the system to be furnished and that the organization is capable of providing repair service within 24 hours of a trouble call.

C. The system shall be installed by an electrical contractor experienced in the installation of addressable fire alarm systems and certified by the National Institute for Certification in Engineering Technologies (NICET) for fire alarm systems. The services of the control equipment factory representative shall be obtained to provide engineered system floor plans and point-to-point drawings on AutoCAD. The representative shall supervise the installation, system start-up, programming, make final adjustments and provide testing of the completed system. The factory representative shall provide a letter of system certification to the Architect.

1.4 CONTRACTOR DESIGN

A. The equipment shown on the contract drawings indicate the general nature of the fire alarm system, but does not show all components required. It is the responsibility of the contractor to provide a complete fire alarm and communications system as needed to meet all applicable codes and requirements under this section.

B. It is the responsibility of the contractor to review various sets of drawings for initiating and notification devices, and provide devices as required to comply with the requirements of the specifications and NFPA 72.

C. Raceway, routing, and wiring for field devices are not shown on the drawings except for a few specific design requirements.

1.5 SUBMITTALS

A. AutoCAD shop drawings with Fire Marshal's stamp of approval.

B. Product data with wiring schematics.

C. AutoCAD wiring diagrams of each type of device.

D. AutoCAD riser diagram of the complete system(s).

E. Battery and voltage drop calculations based on intended routing and wiring.

F. Amplifier sizing calculations.

G. Shop drawings of the system shall be prepared by the manufacturer in AutoCAD and submitted to the Fire Marshal for approval. The approved shop drawings will be utilized as the installation drawings. The shop drawings shall show actual conduit routing and conductors as to be installed. These drawings shall be updated by the contractor to include any revisions and changes to the system during construction and installation.

1.6 SYSTEM DESCRIPTION

A. The automatic fire detection systems shall operate in a local, supervised non-coded fashion. The system shall be low voltage operating at 24 volts DC. The system shall be fully addressable with analog technology for all sensors. Signal circuits shall be either class "A" or "B" without changing modules. System shall be designed class "B". All circuits shall be loaded to 75 percent capacity maximum.

B. All signal, visual and audible alarms, communication circuits, flow and tamper circuits shall be supervised for all opens, shorts and grounds. Any open, short or ground shall cause a trouble on the system, sound the audible trouble sounder and annunciate at the control panel and remote annunciator: the device, location and nature of the trouble condition.

1.7 SYSTEM OPERATION

A. Operation of any manual or automatic initiating device shall cause an audible and visual alarm to sound, activate the control-by-event program and perform all auxiliary functions.

B. Any fault in the circuits shall be annunciated at the control panel and the remote annunciators.

C. System shall utilize a single pair of wires to power, transmit and receive data from the addressable analog initiating devices and to transmit commands to the remote control points. The wire shall be sized for the length of communications loop but in no event shall it be less than number 18-2 wire size.

1.8 SEQUENCE OF OPERATION

A. The system alarm operation subsequent to the alarm activation of any manual station, automatic initiating device, or sprinkler flow/pressure switch is to be as follows:
   1. Audible alarm indicating appliances shall sound a digitized tone in the elevators, stairwells and the floor initiating the alarm until silenced by the alarm silence switch at the control panel.
   2. All visual alarm indicating appliances (xenon strobes) shall display a continuous pattern until extinguished by the alarm silence switch.
   3. All doors normally held open by door control devices shall release. Door lock systems shall be signaled to unlock.
   4. A supervised signal to notify an approved central station shall be activated.
   5. Combination fire/smoke dampers shall de-energize to normally closed position.

B. The alarm activation of any elevator lobby, hoistway, or machine room smoke or heat detector shall in addition to the operations listed above, cause the elevator cab to be recalled according to the following sequence:
   1. If the alarmed detector is on any floor other than the preferred level of egress, the elevator cab shall be recalled to the preferred level of egress.
   2. If the alarmed detector is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.
   3. The activation of any heat detector in an elevator hoistway or machine room shall automatically disconnect power to the elevator motor via base-mounted contacts activating the elevator feeder shunt-trip circuit breaker. Refer to drawings.

C. The control panel shall have a dedicated supervisory service indicator and a dedicated supervisory service acknowledge switch.

D. The activation of any standpipe or sprinkler valve tamper switch shall activate the system supervisory service audible signal and illuminate the indicator at the control panel.
   1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory serviced LED on indicating the tamper contact is still in the off-normal state.
   2. Restoring the valve to the normal position shall cause the supervisory service indicator to extinguish thus indicating restoration to normal position.

E. The activation of any sprinkler pre-action system pressure or low air switch shall activate the system supervisory service audible signal and illuminate the indicator at the control panel.
   1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory service indicator on indicating the pressure/air contact is still in the off-normal state.
   2. Restoring the air pressure to the normal shall cause the supervisory service indicator to extinguish thus indicating restoration to normal position.

F. Alarm and trouble conditions shall be immediately displayed on the control panel front alphanumeric display and of remote annunciators. If more alarms or troubles are in the system the operator may scroll to display new alarms.

G. The system shall have an alarm list key that will allow the operator to display all alarms, troubles, and supervisory service conditions with the time of occurrence.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Firelite

B. Owner expected equipment as follows:
   1. Control Panel: Firelite MS9600UDLS
   2. Voice Evacuation: Firelite ECC-50/100 and compatible Firelite Amplifiers
   3. Firefighter’s Interface: Firelite ECC-FFT

4. Annunciator: Firelite ANN80
5. Smoke Detector: Firelite SD355
6. Thermal Detector: Firelite H355R
7. Pull Station: Firelite BG12LX
8. Duct Smoke Detector: Firelite D355PL with CRF300 relay module
9. Monitor Module: Firelite MMF300
10. Control Module: Firelite CMF300
11. Relay Module: Firelite CRF300
12. Speaker/Strobe: Wheelock Series E50H/E60H
13. Strobe: Wheelock STR
14. Exterior Speaker: Wheelock Series E1010
15. NAC Power Supply: Silent Knight 5499

C. Contractor shall verify with fire alarm system manufacturer the list above and related part numbers and provide complete fire alarm system head-end, controls and devices with are compatible with and listed for operation with each other.

D. Any deviations should be noted at time of bidding through a substitution or information request.

2.2 CONTROL PANEL

A. Provide processor, switches, relays, solid state indicator lamps and displays, wiring, terminals, etc., as required for operation, supervision and control of complete system.

B. General: Microprocessor based, point identified system utilizing twisted pair 18 to 12 AWG, depending on distance, class B communication loop. Equip for a minimum of four loops.

C. Cabinet: 16-gauge enameled steel designed for two level access. Level 1 to give access to the interface control panel. Level 2 to give access to the electronics.

D. Outputs: Two general alarm signal circuits, programmable signal circuits, alarm contacts, trouble contacts, and RS485 annunciator line circuit.

E. Controls and Displays: Alarm silence, trouble silence, alarm/trouble acknowledge, and reset switches, 80-character LCD display, touch keypad, and power indicator.

F. Power Supply: Minimum 1.8 amperes of regulated, filtered power at 24 VDC plus 3.0 amperes unregulated.

G. Failsafe Auxiliary Degrade Alarm Circuit: System will perform basic detection and alarm function and send a signal to the fire department with the CPU failed.

H. Two-Way Loop: System capable of addressing and operating smoke detectors, manual pull stations, open contact devices and addressable auxiliary control relays on the same two-wire communication loop.

I. Battery Back-up: Self-charging sealed lead battery backup for system auxiliary power supplies and remote annunciators in accordance with code requirements (operate 24 hours, then alarm for 10 minutes, minimum). Batteries to be monitored and initiate a trouble signal if disconnected or discharged more than 15 percent.

2.3 FIRE COMMUNICATIONS CONTROL PANEL

A. Audio amplifiers shall be supervised, solid-state amplifiers having a frequency response of 100 to 6,000 Hz + 3dB with less than 5% distortion at rated output. The audio amplifiers shall be supervised and provide a distinct visible indication should failure occur and the system trouble signal will sound. The amplifiers shall have short-circuit protection to prevent damage due to inadvertent speaker line shorts. Upon amplifier failure, the system shall automatically switch to a backup amplifier. Capacity and number of amplifiers to be determined by total anticipated speaker load in building and provide a 5% spare capacity.

B. Provide multiple circuits of parallel connected alarm speakers zoned as required. The speaker circuits shall be independently programmable and provide a distinct visible signal as a result of any shorts, opens or grounds in the speaker circuit wiring and the system trouble signal shall sound and the zone in trouble annunciated. Accessible controls shall be provided and identified to allow authorized personnel to transmit voice messages to individually selected signal zones. Visible indicators shall be provided to indicate that the individual signal circuit selector switch is in the voice position. Each output circuit shall have a modulation indicator for visual monitoring of circuit outputs.

C. Provide a hand held press-to-talk microphone for transmission of messages. This module shall provide facilities to manually control the audio alarm system and transmit verbal instructions to all areas, zones, or floors, or any combination desired by the Fire Marshal.

2.4 CENTRAL STATION REPORTING

A. Provide digital alarm communication transmitter (DACT) internal to FACP

2.5 STROBE SYNCHRONIZATION MODULE

A. Synchronize all strobes to 1Hz flash to comply with the Americans with Disabilities Act (ADA).

2.6 SOFTWARE

A. Field Configuration Program: Provide all of the programmable operating instructions for the system resident program stored on a non-volatile EEPROM.

B. Programming: Perform at the location of the fire alarm control using a lap-top computer system; hard copy of the system configuration is to be updated and maintained at the site.

C. Control-By-Event: Each address shall be programmed for selective alarm output, zone verification operation, control point activation on alarm or trouble and transmit alarm to the fire department. Report trouble to adjacent attached building fire alarm system. Programmed control point activation to provide selective control.

2.7 REMOTE EQUIPMENT

A. Annunciator Control Panels: Alphanumeric display module:
   1. 80 character LCD display, back lighted.
   2. System acknowledge, signal silence, and system reset touchpad control switches.
   3. Time/date display.
   4. Integral sounder with subsequent alarm/trouble resound.
   5. Flush mounting.

B. Transponders: Up to 26 field configurable circuits of any mix. Full LED/LCD display of alarm and trouble per point. Status displays and controls including power, on-line, local alarm and local trouble LED/LCD’s plus reset and lamp test switches. Power supply, charger and battery as required for control panel.

C. Lamp Driver Modules: Field selectable alarm and trouble or alarm only. Integral system trouble lamp on-line/power LED/LCD, alarm and trouble resound with flash function of new events, serial RS-485 interface to control panel, capable of being powered remotely or locally with supervision. Integral lamp test function.

D. Power supplies, with integral chargers and batteries current limited low energy as recommended by the manufacturer but sized for 25% spare capacity.

2.8 ELECTROMAGNETIC DOOR HOLDERS

A. Equipment shall consist of an armature contact plate with adjustable pivot mount, to be installed on door. A heavy-duty electromagnet, in a durable enclosure to be mounted behind the door on the wall or floor.

B. Fail-Safe operation, loss of power shall release the door holder for the door to close.

C. Unit shall accept 12VDC, 24VAC/VDC or 120VAC. Voltage shall be coordinated by the fire alarm system installer/supplier. Any circuitry required for the systems operation shall be provided by the system installer.

D. All door holder equipment shall be of the same manufacturer as the fire alarm system to ensure system compatibility and proper UL compatibility listings.

2.9 DETECTION DEVICES

A. Analog photoelectric smoke detectors shall provide for individual addressing of each detector. The sensor is constantly monitored to measure any change in its sensitivity due to the environment caused by dirt, aging, temperature, humidity, etc. It shall give an advanced indication to the control panel of the need for maintenance and can be specific as to where the maintenance is needed. It is to be mounted on a two wire standard device base. Photo electric detectors located within the elevator shaft shall be rated for installation within a pressurized shaft.

B. Analog thermal detectors consist of a dual thermistor sensing circuit for fast response. The sensor is continually monitored to measure any changes in their sensitivity due to temperature. It shall give an advanced indication to the control panel of the need for maintenance and can be specific as to where the maintenance is needed. It is to be mounted on a two wire standard device base. Thermal detectors in elevator shafts and machine rooms shall be equipped with a set of auxiliary contacts for elevator equipment use. Thermal detectors located within elevator shaft shall be rated for installation within a pressurized shaft.

C. Projected beam type smoke detectors shall be four-wire 24 VDC and powered from the control panel four-wire smoke power source. This unit shall consist of a separate transmitter and receiver capable of being powered separately or together. This unit shall operate in either a short range of 30 to 100 feet or a long range of 100 to 300 feet. The detector shall feature a bank of four alignment LEDs on both the receiver and transmitter that are used to ensure proper alignment without the use of special tools.
   1. The beam detector shall feature automatic gain control that shall compensate for gradual signal deterioration from dirt accumulation on lenses. Ceiling or wall mount as shown on the drawings. Testing shall be carried out using calibrated test filters. Provide a key activated remote test station.
   2. Provide monitor modules for alarm and trouble and control relay module for reset.

D. Addressable monitor modules shall provide an address for a single, normally open initiating device such as a waterflow switch, manual station, etc. The monitor module shall be UL approved to extend the sensor loop to lengths up to 2,500'.

E. Provide smoke detector duct housing assemblies to mount an analog/addressable detector along with a standard, relay or isolator detector mounting base. The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided. The housing shall be finished in baked red enamel. Remote alarm LED indicators and remote test stations shall be provided.

2.10 MANUAL PULL STATIONS

A. Single action, addressable, constructed of all metal construction with a key reset switch for positive authorized resetting action. The unit to be keyed the same as the control unit.

2.11 ANNUNCIATION DEVICES

A. Horns and combination horn/strobe mounted to a recessed box with an extension ring. Front of the unit shall allow for candela light levels as required by ADA for the spacing as installed. Horns shall provide a 100 dba peak sound output with field adjustable output level. Finish to be white or red as selected by the Architect.

B. Strobe lights shall be triangular with "FIRE" on white plastic lens, polarized 24 VDC, mounting single gang on four square box. Front of the unit shall allow for candela light levels as required by ADA for the spacing as installed. Strobe candela level shall be field adjustable from 15-110 CD. Mount at 80" or as shown on drawings. Finish to be white or red as selected by the Architect.

C. The candela rating of each strobe installed shall be apparent to the Fire Marshal and to qualified service personnel either as installed or with the removal of the faceplate. If faceplates are interchangeable between strobes of different ratings the indication of candela rating shall not be on the faceplate.

D. Speakers shall be mylar cone-type supplied by the panel manufacturer to ensure system compatibility and proper UL compatibility listings. Screw terminals shall be provided for wiring. Speaker housings shall be white. Speakers shall have power taps at 1/4w, 1/2w, 1w, and 2w. Speakers shall provide 90 dBA peak sound output at 2w. Speakers shall mount in 4-inch electrical boxes with extension rings using the two screws provided with each ring.

2.12 ADDRESSABLE ACCESSORIES

A. Control Modules: Connects to the same loop as the initiating devices and provides a form “C” relay contact. The module may be programmed to transfer from either a trouble or alarm input from any or combination of any addressable device.

2.13 CONTROLLED DEVICES

A. Mechanical control system for control of air handlers and smoke/fire rated dampers.

B. Fire protection tamper, flow, dry system and preaction system.

2.14 CABLE

A. Cabling shall be multi-conductor solid copper, with red jacket, sized per manufacturer’s recommendations, and as shown on approved fire alarm shop drawings.

B. Plenum rated as recommended by System Manufacturer and as required for the building construction methods.

C. Circuit Integrity (CI) rated as and where required by NFPA 72 Ch 6.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install in accordance with code, IFC, IBC, NFPA 72, 101 and the manufacturer’s instructions. Review proper installation of each type of device with manufacturer’s agent. Install all wiring, raceway and outlet boxes required for a complete system as indicated in the Contract Documents. Comply with applicable requirements of Section 260533 for boxes and surface mounted raceways.

B. Typical Wiring: Install manufacturer’s recommended listed cable to connect all devices as recommended by the manufacturer. The cable shall be run in conduit where exposed to physical damage.

C. Detectors: Locate 48” clear of supply air vents and 12” clear of lights and sprinkler heads. Install detector heads not more than two weeks prior to substantial completion. Verify the design locations shown conform to the actual construction. Do not locate detectors in close proximity to air supply vents. Bring cases of uncertain applicability to the attention of the Architect for resolution prior to roughing in.

D. Install remote annunciator as indicated on plans and where required by Fire Marshall. Coordinate prior to rough-in.

E. Provide auxiliary power supplies as required and extend the 120V power to the power supply as required and per NEC.

F. Provide visual devices and alarm devices as required. Device locations are diagrammatic showing intent of area coverage. The exact quantity placement, sound or light level is to be per the requirements and the listing of the manufacturer's equipment and NFPA 72 installation requirements for the device(s) installed and the building conditions at and adjacent to the device(s). Provide ceiling mounted devices in lieu of wall mounted devices where desired by the Architect/Owner. Coordinate with Architectural ceiling and floor plans and obtain approval for dimensional locations prior to rough-in and device installation.

3.2 LABELING

A. Label all alarm initiating devices with ½-inchx1-inch lamicoid nameplates, indicating control panel point designation. Locate nameplates in the vicinity of the device as approved by the Owner.

B. Provide Brady type wire markers to identify all conductors at each junction or terminal. Use numbers indicated on the wiring diagrams.

3.3 TESTS

A. Provide the service of a competent, factory-trained technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during the programming, final connections, adjustments and tests for the system.

B. When the system is complete and prior to the substantial completion, furnish testing equipment and perform the following tests:

C. Before energizing system, check for correct wiring connections and test for short circuits, ground faults, continuity, and insulation.

D. Test the insulation on all installed wiring by standard methods as recommended by the equipment manufacturer.

E. Open all supervised circuits to see if the trouble signal activates.

F. Ground all supervised circuits and verify response of trouble signals.

G. Check installation, supervision, operation and sensitivity of smoke detectors as recommended by the manufacturer to ascertain that they will avoid false alarm signals yet provide the required automatic detection.

H. Test each device for proper operation and auxiliary function.

I. Submit a print out of the entire test procedure to the engineer with the letter of certification for the completed fire alarm system.

J. When any defects in the work are detected, make repairs and repeat the tests as required.

K. Test system for NFPA standby and alarm runtime for the actual load on the system batteries and recharge time of system batteries.

L. Perform all required and necessary verification of the system operating functions with the Architect and Owner's facility staff prior to turnover of the complete system for final test observed by the Fire Department. These tests shall be performed in the presence of the Owner or the Owner's Representative. A System Certification verifying the proper system operation is required prior to acceptance. Instruct Owner's personnel in system operation, maintenance and programming for a minimum of twenty (20) hours. The cost of any retesting as a result of the failure of the system to operate in accordance with these specifications, drawings, or applicable codes shall be paid for by the contractor to the Owner.

3.4 WARRANTY SERVICE AND INSTRUCTION

A. The fire alarm system will be checked on a monthly basis by the fire alarm system service organization for a period of one year after beneficial occupancy. The monthly checks will consist of reviewing the operation of the system with the Owner's operating and maintenance personnel, providing additional hands on instruction, and assisting in execution of programming revisions. Each monthly visit will consist of not less than two hours of on-site time and no more than four hours. The monthly visits will be scheduled with the Owner not less than one week in advance.

3.5 EXTRA STOCK/SPARE PARTS

A. Provide the following equipment to be turned over to the owner with the operation and maintenance manuals.
   1. 2 photoelectric smoke detector heads
   2. 2 thermal heat detector heads
   3. 1 addressable dry contact modules
   4. 2 horns
   5. 2 horn/strobe
   6. 2 speakers
   7. 1 manual pull stations
   8. 1 complete set of fuses to match panel counts

3.6 TRAINING

A. Provide operation and maintenance training for Owner's personnel.

B. Conduct a minimum of two maintenance training sessions upon completion of the work. Maintenance training sessions shall include a walk-thru of the completed facilities identifying the location, address, and means of access to every device monitored by the fire alarm system.

C. Conduct training sessions for two operator levels.

D. Operator training. Provide a minimum of three refresher and system update training sessions of on-the-job training.

E. Supervisor training. Provide a system update training session for supervisory functions.

F. Training sessions with fully qualified, trained representative, of the equipment manufacturer who is thoroughly knowledgeable of the specific installation.

END OF SECTION

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Preparing subgrades
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Base course course for concrete walks and pavements.
5. Base course course for asphalt paving.
6. Excavating and backfilling for utility trenches.
7. Drainage fill for infiltration facilities.

1.2 SUBMITTALS

A. Product Data.

B. Aggregate Sieve Analysis.

C. Growing media: (at least 14 days in advance of construction).
1. Documentation for the two analyses described in article 2.1.N.1 and 2.1.N.2 of this specification (particle gradation with calculated coefficient of uniformity; and pH) shall be performed by an accredited laboratory with certification maintained current. The date of the analyses shall be no more than 90 calendar days prior to the date of the submittal. The report shall include the following information:
   a. Name and address of the laboratory.
   b. Phone contact and e-mail address for the laboratory.
   c. Test data, including the date and name of the test procedure.
2. A compost technical data sheet from the compost vendor. The analysis and report must conform to the sampling and reporting requirements of the US composting Council Seal of Testing Assurance (STA) program. The analysis shall be performed and reported by an approved independent STA program laboratory and be no more than 90 calendar days prior to the date of submittal.
3. Two gallon-sized bags of the blended material.
4. A description of the location, equipment, and method proposed to mix the material.

1.3 DEFINITIONS

A. Wet Weather: Any weather or subgrade conditions that preclude compaction of subgrade or created workability problems.
1. Any time between October 14th and April 15th should be considered wet weather regardless of subgrade conditions.

B. Backfill: Soil material 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.

C. Base Course: Course placed between the subbase course, or subgrade, and concrete, or hot-mix asphalt paving.

D. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

F. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and 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. Subgrade: Surface or elevation remaining after completing excavation, or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

L. Drainage Fill: Free draining, open-graded aggregate course used to support pervious pavement or in drainage zones in flow-through planters, vegetated stormwater facilities and infiltration galleries.

M. Choking Layer: Free draining, small, open-graded aggregate course used to filter out fines prior to stormwater reaching stormwater facility reservoirs.

N. Growing media: Non-native soil mixture made up of sand, loam, and compost; used on surface stormwater facilities.

O. Clay Lens: Compacted clay that provides proofing.

P. Unified Soil Classification System:
   1. GW: Well-graded gravels; gravel/sand mixtures with little or no fines.
   2. GP: Poorly-graded gravels; gravel/sand mixtures with little or no fines.
   3. GM: Silty gravels; poorly-graded gravel/sand/silt mixtures.
   4. GC: Clayey gravels; poorly-graded gravel/sand/clay mixtures.
   5. SW: Well-graded sands' gravelly sands with little or no fines.
   6. SP: Poorly-graded sands; gravelly sands with little or no fines.
   7. SM: Silty sands; poorly, graded- sand/gravel/silt mixtures.
   8. SC: Clayey sands; poorly-graded sand/gravel/clay mixtures.
   9. ML: Inorganic silts; sandy, gravelly, or clayey silts.
   10. CL: Lean clays; inorganic, gravelly, sandy, or silty, low to medium-plasticity clays.
   11. OL: Organic, low-plasticity clays and silts.
   12. MH: Inorganic, elastic silts; sandy, gravelly or clayey elastic silts
   13. CH: Fat clays; high-plasticity, inorganic clays.
   14. OH: Organic, medium to high-plasticity clays and silts
   15. PT: Peat, humus, hydric soils with high organic content.

1.4 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

B. 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.

C. Site Information: Research public utility records and verify existing utility locations prior to ordering any material. Notify the Architect immediately if any discrepancies are found in the project survey.

D. See Geotechnical report titled Roosevelt Middle School Geotechnical Investigation and Seismic Hazard Study by Foundation Engineering, Inc. dated April 23, 2014 for additional information and requirements.

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: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
2. On-site soils are considered unsatisfactory and may not be used as fill.

D. Base Course: Use Oregon Standard Specifications for Construction 3/4-inch-0" BASE AGGREGATE.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; well-graded, with at least 90 percent passing a 3-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Bedding Course: Use Oregon Standard Specifications for Construction ¾-inch—0-inch BASE AGGREGATE.

G. Drainage Course: Well-graded mixture of washed crushed stone, or crushed gravel; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 200 sieve. Referred to as "Select Fill" in Geotechnical Report.

H. Backfill and Fill:
1. Satisfactory soil materials
2. Initial trench backfill: Use OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION 3/4-inch – 0-inch base aggregate.

I. Drainage Fill: Angular, granular material with a maximum particle size of 2 inches and shall meet Oregon Standard Specification 00430.11. The material shall be free of roots, organic material, and other unsuitable materials; have less than 2 percent passing the No. 200 sieve (washed analysis); and have at least two mechanically fractured faces.

J. Choking Layer: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; AASHTO course-aggregate grading size #7.

K. Compacted Clay Lens: Compacted cohesive clay at 95% of maximum dry density. Clay must contain a minimum of 25% minus no. 200 sieve, with 70% passing a ¾" sieve. Native clay acceptable with prior approval from engineer.

L. Growing Media: A loose and friable material blend of loamy soil, sand and compost that is 30-40 percent compost (by volume) and meets the following other criteria:
1. Particle Gradation: A sieve analysis of the complete blended material shall be conducted per ASTM C117/C136, AASHTO T11/T27, or ASTM D422/D140 and meet the following gradation criteria:

Sieve Size	Percent Passing
1-inch	100
#4	75-100
#10	40-100
#40	15-50
#100	5-25
#200	5-15

The blend shall have a coefficient of uniformity (D60/D10) equal to or greater than 6 to ensure it is well graded.

2. Acidity: pH of the blended material shall be tested and be between 6 and 8.
3. Compost: The compost shall be derived from plant material and provided by a member of the US Composting Council Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers. The compost shall be a result of biological degradation and transformation of plant-derived materials under conditions designed to promote aerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have no visible free water and produce no dust when handled. It shall meet the following criteria, as reported by the US Composting Council STA Compost Technical Data Sheet provided by the vendor.
   a. 100 percent of the material must pass through a ½ inch screen.
   b. The pH of the material shall be between 6 and 8.
   c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight.
   d. The organic matter content shall be between 30 and 70 percent (dry weight basis).
   e. Soluble salt content shall be less than 6.0 mmhos/cm.
   f. Maturity indicator shall be greater than 80 percent for Germination and Vigor.
   g. Stability shall be 'Stable' to 'Very Stable'.
   h. Carbon/Nitrogen (C/N) ratio shall be less than 25:1.
   i. Trace metals test result= 'Pass.'
4. Blend: The material shall be well mixed and homogenous. It shall be free of wood pieces, plastics, and other foreign matter. There shall be no visible free water.
5. Infiltration: The blended material shall have a minimum infiltration rate of 2 inches per hour. Contractor shall provide the Engineer with a 2 quart sample for initial testing.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction or 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.

B. Tracer Wire: 12 AWG minimum solid copper insulated High Molecular Weight Polyethylene (HMW PE) tracer wire or approved equal. The tracer wire insulation shall be green for sewer pipe and blue for waterlines and be a minimum of 45 mil. thick. Joints or splices shall be waterproof. The wire shall be rated for 30 Volt.

C. Impermeable liner: PVC or HDPE Geo-membrane textured on both sides, 30 mil (.076mm) minimum.

D. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
1. Grab Tensile Strength: 110 lbf; ASTM D 4632.
2. Tear Strength: 40 lbf; ASTM D 4533.
3. Puncture Strength: 220 lbf; ASTM D 4833.
4. Apparent Opening Size: No. 40; ASTM D 4751.
5. Permativity (minimum): .5 sec^{-1}; ASTM D 4491.

E. Separation Fabric: Woven geotextile, specifically manufactured as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
1. Grab Tensile Strength: 180 lbf; ASTM D 4632.
2. Tear Strength: 68 lbf; ASTM D 4533.
3. Puncture Strength: 371 lbf; ASTM D 4833.
4. Apparent opening size: No. 30; ASTM D 4751.

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 earth moving operations. Provide protective insulating materials as necessary.

B. Protect and maintain erosion and sedimentation controls, which are specified the 1200-C Permit and Plans.

C. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

D. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

E. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

F. Protect all areas designated to be infiltration facilities from foot or equipment traffic and surface water runoff. Do not use proposed infiltration facilities to dispose of surface water runoff during construction. Under no circumstances shall material and equipment be stored on top of the installation area. Contractor shall not backfill facility until Engineer has inspected it and signed off.

G. Protect all areas designated to receive pervious pavers or pervious pavement from excessive compaction.

H. If any subgrade has been disturbed by construction or construction equipment, disturbed subgrade to be overexcavated by 24”, overlaid with separation fabric, and replaced with 24-inch thick base rock section at the expense of the contractor.

3.2 EXPLOSIVES

1. Explosives: Do not use explosives.

3.3 EXCAVATION

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will

be authorized for rock excavation or removal of obstructions without prior approval by the Architect.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 WET WEATHER GRADING, EXCAVATION, OR FILL

A. No grading shall be done during wet weather without prior approval from Geotechnical Engineer.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, 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.

B. Building pad construction during wet weather is not recommended. Prepare the pads for the structure in dry weather as follows:

1. Strip 4” from the existing site or as require to remove roots or sod. Geotechnical engineer to confirm stripping depth during construction. Strippings must be hauled off site or reused only under landscape areas. Strippings may not be placed beneath foundations, slabs, sidewalks, or pavements.
    a. In areas of conventional slab or footing: Excavate the underlying plastic clay to a depth of 4 to 5 feet, to be confirmed by Geotechnical Engineer during construction. The limits of the excavation should extend at least 5 feet beyond the outside edge of any foundation or slab.
    b. In areas of piles: Excavate to 4.2’ below finish floor elevation. Install separation fabric, then 1.75’ of engineered fill topped with 3” of base course prior to any equipment working within the building pad area.
2. Do not re-use clay as site fill.
3. Over excavate any test pits that extend below the bottom of the building pad excavation and replaced with compacted Drainage Course, Base Course, or Engineered Fill.
4. Do not compact the exposed subgrade. Grade the bottom of the excavation to direct any water that would tend to accumulate on the subgrade to one or more corners. Install manholes or sumps equipped with a submersible pump and float controls as required to dewater the granular pad during wet weather.
5. Do not allow the subgrade to dry. Immediately cover the subgrade with a vapor barrier followed by a separation geotextile.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Subgrade preparation should be done in dry weather.

1. Strip 4” from the existing site or as require to remove roots or sod. Geotechnical engineer to confirm stripping depth during construction. Strippings must be hauled off site or reused only under landscape areas. Strippings may not be placed beneath foundations, slabs, sidewalks, or pavements.
2. Grade the subgrade as required. Do not reuse materials generated by site grading under any sidewalk, parking lots, or foundation areas.
3. Compact the subgrade under pavements to a depth of 12 inches. Compaction may not be practical if the soils are too wet of optimum. Therefore, the site work should not be attempted during wet weather and should be delayed until the subgrade soils are sufficiently dry or until weather permits efficient aeration. Compaction of stiff, highly plastic clays should not be attempted.

4. If wet weather construction cannot be avoided, do not compact the subgrade. Instead, over excavate the subgrade to provide a minimum 24-inch thick base rock section. In lieu of subgrade compaction, the thickened base rock should be left in place for pavement construction.
5. Place a Separation Geotextile over the prepared subgrade under staging areas, haul roads, or other areas subject to heavy traffic. Install a Separation Geotextile if overexcavation and additional subbase is planned in lieu of subgrade compaction. Place a Separation Geotextile under all bus lanes and driveways.
6. If any subgrade has been disturbed by construction or construction equipment, disturbed subgrade to be overexcavated by 24", overlaid with separation fabric, and replaced with 24-inch thick base rock section at the expense of the contractor.
7. Cover the prepared subgrade with Select Fill or base rock immediately.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 6 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade and bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course. Hand excavate for bell of pipes.
   2. Excavate utility structures to provide 6 inches clearance (enlarge as needed) to allow for compaction of backfill material.

3.8 EXCAVATION FOR STORMWATER INFILTRATION FACILITIES

A. Excavate facilities to the indicated gradients, lines, depths, and elevations. All excavations shall be performed with the lightest practical excavation equipment. Excavation equipment shall not be operated within the limits of the facility.

B. To help prevent subgrade soil contamination and clogging by sediment, facility construction shall be delayed until all other construction within its drainage basin is completed and the drainage area stabilized. Provide additional sediment control measures such as diversion berms around the facility as needed. Additional excavation and backfill required to restore any infiltration rate lost due to clogging or over-compaction during construction shall be performed by the contractor at no cost to the owner.

3.9 SUBGRADE INSPECTION

A. Proof-roll subgrade with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Do not proof-roll subgrade in infiltration facilities.

B. Soft pockets and areas of excess yielding that have been identified shall be scarified and moistened or aerated, or removed and replaced with suitable soil materials to the depth required. Re-compact and retest until specified compaction is obtained.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.10 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, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory 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.

3.12 BACKFILLS AND FILLS

A. Backfill: 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.

3.13 UTILITY TRENCH BEDDING

A. Place bedding on subgrades free of mud, frost, snow, or ice.

B. 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.

3.14 UTILITY TRENCH BACKFILL

A. Trenches under Footings: Backfill trenches excavated under footings with satisfactory soil or approved backfill to within 18 inches from the bottom of footings elevation; fill remaining trench excavation with concrete up to the elevation of bottom of footings. Concrete is specified in "Cast-in-Place Concrete."

B. Place and compact initial trench backfill material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

C. Place and compact final backfill of satisfactory soil to final subgrade elevation.

D. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

E. Install tracer wire in a continuous fashion above the utility in such a manner as to be able to properly trace utility lines without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire. Bring tracer wire to the surface at every box, vault, drainage structure, or manhole.

F. At all building connections, place a 6-inch thick lens of compacted clay to protect building.

3.15 DRAINAGE FILL

A. Compaction of the native soil subgrade should be limited in order to prevent a reduction in the permeability of the soil.

1. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and underlying soils scarified to a minimum depth of 3 inches with a York rake or equivalent and light tractor.
2. Where subgrade has been compacted due to construction traffic, subgrade shall be scarified or removed to a depth sufficient to match the naturally occurring insitu state. Add additional base course material to meet design grades at no cost to the owner.
3. Bring subgrade of base course to line, grade, and elevations indicated. Fill and lightly re-grade any areas damaged by erosion, ponding, or traffic compaction before the placing of stone.

B. Place drainage geotextile over prepared subgrade, overlapping ends and edges at least 12 inches. Secure in place to prevent wrinkling.

C. Place drainage fill and compact by tamping with a plate vibrator, and screed to depth indicated. For drainage fill that exceeds 8 inches in compacted thickness, place fill in layers of equal thickness, with no compacted layer more than 8 inches or less than 4 inches thick.

D. Place drainage geotextile over compacted drainage fill, overlapping ends and edges at least 12 inches.

3.16 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. 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 base course.
3. Under steps and ramps, use base course.
4. Under building slabs, use drainage course.
5. Under footings and foundations, use drainage course.
6. Under and around utility structures, use engineered fill.

3.17 STORMWATER INFILTRATION FACILITY FILL

A. Growing media shall be placed in loose lifts, not to exceed 8 inches each.

B. Placement of the growing media will not be allowed when the weather is too wet as determined by the owner's representative.

3.18 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
1. Do not place backfill or fill soil 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 3 percent and is too wet to compact to specified dry unit weight.

3.19 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 and ASTM D 1557:
1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

D. Growing media shall be compacted with a water-filled landscape roller. It shall not otherwise be mechanically compacted.

3.20 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1/2 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.21 BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements and walks as follows:
1. Shape base course to required crown elevations and cross-slope grades.
2. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
3. Compact base course 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 698.

3.22 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
3. Excavate for footings as required. Al loose or disturbed granular fill should be removed or re-compacted in the bottom of the footing trenches or excavations. To expedite foundation construction, a thin leveling course of compacted Drainage Course may be placed in the bottom of the footing excavations.

3.23 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: Footing and subgrade excavation shall be inspected by Geotechnical Engineer prior to placing backfill.

D. Testing Agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, 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. 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 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 or less of trench length, but no fewer than two tests.

E. With the approval of the Engineer, proof-roll testing of subgrade and/or aggregate base may be substituted for other compaction testing.

F. 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 materials to depth required; recompact and retest until specified compaction is obtained.

3.24 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.

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 greatest extent possible.

D. Weather permitting and as approved, stormwater infiltration facility plants shall be installed as soon as possible after placing and grading the growing media in order to minimize erosion and further compaction.

3.25 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

DRIVEN STEEL PIPE PILES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Steel pipe piles driven by both hammering and vibration.
   1. Drive piles in accordance with the Geotechnical Report to provide the required pile capacity.
   2. Piles shall be driven to bedrock using impact systems or by vibration method at the option of the Contractor.
   3. Drive and seat all piles into bedrock using an impact hammer. The final set of the piles (used to calculate pile capacity) shall be based on an impact hammer.
   4. “Driving Piles” refers to both installation by vibratory hammers and traditional methods using impact hammers. “Driving Piles” as used in this Section refers to both methods unless the context clearly refers to one method only.

1.02 SUBMITTALS

A. At least two weeks prior to mobilization at the site, submit data fully describing all proposed pile installation equipment including hammers, rams, driving cushions, pile caps and cap blocks to Engineer.

B. Provide certification of yield strength and weldability of steel products by process acceptable to Engineer; mill certificates of chemical and physical properties, or equivalent.

C. Installation Records:

   1. Prepare and submit to the Architect full-length installation records for each pile installed. The records shall be submitted within 2 days after installation is completed for the pile. The records shall include the following minimum information:
      a. Project name and number.
      b. Name of Contractor.
      c. Pile location in pile group and designation of pile group.
      d. Sequence of driving in pile group.
      e. Pile dimensions.
      f. Ground elevation.
      g. Elevation of tip after driving.
      h. Final tip and cutoff elevations of pile after driving pile group.
      i. Records of redriving.
      j. Elevation of splices.
      k. Type, make, model, and rated energy of hammer.
      l. Weight and stroke of hammer.
      m. Type of pile-driving cap used.
      n. Cushion material and thickness.
      o. Actual stroke and blow rate of hammer.
      p. Pile-driving start and finish time; and total driving time.
      q. Time, pile-tip elevation, and reason for interruptions.
      r. Record of number of blows for each 12 inches of penetration, and number of blows per 1 inch for the last 6 inches of driving.
      s. Pile deviations from location and plumb.
      t. Record any special procedures used or occurrences during pile driving.

D. Welding Certificates: Copies of certificates for welding procedures and personnel.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of seven (minimum) completed projects within the last five years with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Mill test reports signed by manufacturer certifying that each of the following complies with requirements:
   1. Steel pipe piles.
   2. Steel castings.
   3. Steel plate.

G. Pile-Driving Equipment: Include type, make, maximum rated energy, and rated energy per blow of hammer; weight of striking part of hammer; weight of drive cap; details, type, and structural properties of hammer cushion; and details of follower and jetting equipment.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing piling similar in material, design, and extent to that indicated for this Project.

B. Survey Work: Surveys, layouts, and measurements related to pile driving shall be prepared by a surveyor or professional engineer who is legally qualified in jurisdiction where Project is located to perform these kinds of services.

C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Oregon and who is experienced in providing engineering services for piles that are similar to those indicated for this Project in material, design, and extent.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

E. Comply with requirements of the following publications:
   1. AISC's "Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings."
   2. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

F. Welding Standards: Qualify welding procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the project site in such quantities and at such times to assure the continuity of pile driving operations to the project schedule.

B. Store piles in orderly groups above group and blocked during storage to minimize possible distortion of members. Piles exhibiting variations beyond tolerance limits will be considered distorted and may not be used in the work.

1.05 PROJECT CONDITIONS

A. Protect structures, underground utilities and other construction from damage caused by pile driving operations. Pre-excavate for piles as required and as specified.

PART 2 PRODUCTS

2.01 STEEL PIPE PILES

A. Steel for Piling: Reference General Structural Notes.

B. Fabrication: Provide splice plates, pile cap plates of the same steel as piling. Fasten to piles with welded connections as shown on drawings.
   1. Piles: Open ended.

2.02 PAINT

A. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide.

1. Color: Black or red.

2.03 DRIVING EQUIPMENT

A. General: Furnish pile driving equipment of a type generally used in standard pile driving practice, operate equipment at manufacturer's specified rate to develop the required rated energy. Drop hammers will not be allowed.

B. Equipment:
   1. Provide equipment of adequate size and capacity to handle, place and hold the piles to the designed alignment. This equipment shall be able to maintain the alignment of pile with driving equipment, without damage to either.
   2. Maintain all pile driving equipment in safe operating condition at all times.
   3. Driving equipment shall be in good repair and operating condition and shall be capable of being operated as recommended by the manufacturer.
   4. Any equipment or methods which result in regular or repeated damage to the piles during driving, or is detrimental to the bearing capacity of piling already driven, will be rejected by the Engineer.
   5. Impact hammers shall be steam, air, or diesel driven that develop a rated energy of at least 5,000 ft-lbs per blow and no more than 17,000 ft-lbs per blow or as required to achieve the required pile tip penetration without overstressing the pile. Contractor is responsible for selecting driving equipment that will not cause damage to the piling or adjacent structures during driving.
   6. Vibratory hammers (if used) shall be of sufficient size and energy to install piles to the bedrock surface.

C. Driving Caps: Provide driving caps capable of protecting pile head and providing uniform distribution of energy to pile head.

D. Leads: Use fixed rigid type pile driver leads that will hold the pile firmly in position and alignment, and in axial alignment with the driving equipment. Free-swinging leads will not be permitted. Extend leads to within 2 feet of the elevation at which the pile enters the ground.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which piles are to be installed, and correct conditions detrimental to the proper and timely completion of the work. Proceed with work only after unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 PRE-DRIVING WORK

A. Site Conditions: Do not drive piles until the earthwork in the area which piles are to occupy has been completed, as follows:
   1. Excavations: Earth excavation will be stopped at an elevation of 6 inches to 12 inches above the bottom of the footing before piles are driven. Final excavation of the required elevation of footing bottoms will be done as part of the earthwork, after the piles have been driven.
   2. Fills: Fills will be constructed and compacted to the elevation of the grade indicated.
   3. Mobility of the Contractor's equipment in the excavation is the Contractor's responsibility.

B. Pile Length Markings: Mark each pile with horizontal lines at 1'-0" intervals, and the number of feet from pile point at 5'-0" intervals. In order to be able to measure the driving resistance, mark the last 60 inches at one-inch intervals.

C. Welding:
   1. Perform manual arc-welding using shielded metal arc or submerged arc method, complying with AWS Standards and requirements of the City.

2. Use oxygen-gas or oxygen arc methods for field cutting of steel, complying with AWS recommendations.

D. Welded Splices: Clean surfaces to be welded of rust, scale, oil, paint, and foreign material. Use only pile members with identical cross-sections for splicing.
   1. Only one splice per pile will be permitted, unless otherwise authorized by the Engineer. Make splices before starting driving operations wherever possible. If a welded splice is required during driving operation, make splice when top of drive pile portion is at least 3'-0" above ground, to permit inspection of welded connection during welding and during subsequent driving.
   2. Splices shall be 100% butt welded, producing straight pile alignment through splice and developing full strength of pile in both bearing and bending.

3.03 DRIVING PILES

A. General:
   1. Drive each pile at the locations indicated, to satisfactory embedment and driving resistance directed by the Geotechnical Engineer.
      a. Pile Lengths: Conform to recommendations of Geotechnical Report as stated on Drawings to provide piles of sufficient length to embed into bedrock and develop the capacity indicated on the Drawings.
      b. Engineer reserves the right to modify driving criteria depending on the equipment used, field conditions encountered and observations made during pile installation.
   2. Carefully maintain the center of gravity for each group or cluster of piles to conform to the locations shown on the drawings.
   3. Carefully plumb the leads and the pile before driving. Take care during driving to prevent and toe correct any tendency of piles to twist or rotate.
   4. Avoid excessive driving as established by the Geotechnical Engineer.

B. Driving Tolerances: Drive piles within the following maximum tolerances:
   1. Location: 3 inches from location indicated for center of gravity of each single pile or pile groups; 2 inches for piles under walls.
   2. Plumbness: Maintain 1 inch in 10'-0" from the vertical, or a maximum of 4 inches, measured when the pile is above ground, in the leads.
   3. Batter Angle: Maximum 1 inch in 10 feet from required angle, measured when pile is above ground in leads.

C. Heaved Piles: Compile recorded instrument observations made during pile driving to determine whether a driven pile has lifted from its original seat during the driving of adjacent piles. If uplift occurs, redrive the affected piles to a point elevation at least as deep as the original point elevation with a driving resistance at least as great as the original driving resistance.

D. Damaged or Misdriven Piles:
   1. Damaged piles, and piles driven outside the required driving tolerances, will not be accepted.
   2. Withdraw piles rejected after driving, and replace with new piles.
   3. Drive additional pile or piles where the centerline deviation exceeds 3 inches and an analytical determination indicates a load on any pile exceeding 110% of the design load. Modify to suit project or choose 4 or 5.
   4. Fill holes left by withdrawn piles that will not be filled by new piles using flowable cementitious fill.

E. Cutting-Off:
   1. Cut-off tops of driven piles, square with pile axis and at elevations indicated.

F. Pile Caps: After pile is cut-off, weld steel plates in place, square and level on top of pile as shown on the structural drawings. Provide steel reinforcing on top of piles as shown on the structural drawings.

3.04 FIELD QUALITY CONTROL

A. Install a minimum of four indicator piles as directed by the Geotechnical Engineer, in order to verify design pile lengths.

B. Indicator piles, furnished and driven by Contractor to determine lengths of piles, may become part of foundation system provided they conform to the contract requirements.

C. Driving Indicator Piles:
   1. Use piles of the same diameters and lengths as those to be used in the work and drive with the appropriate pile driving equipment operating at the rated driving energy proposed to be used for the balance of the work.
   2. Drive indicator piles at locations selected by the Geotechnical Engineer to the specified driving resistance and capacity.

D. Survey: Employ independent Professional Land Surveyor or Registered Civil Engineer to make field survey of completed piling. Show actual pile locations with respect to planned pile locations; and plumbness.

E. Weld Testing: In addition to visual inspection, welds will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option. Correct deficiencies in and retest welds to determine compliance with requirements.
   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
   4. Ultrasonic Inspection: ASTM E 164.

3.05 TOUCHUP PAINTING

A. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.
   1. Apply touchup paint before driving piles to surfaces that will be immersed or inaccessible after driving.

3.06 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION

ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt patching.
   2. Hot-mix asphalt paving.
   3. Pavement-marking paint.

B. Related Requirements:
   1. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 SUBMITTALS

A. Product Data: For each type of product. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the work.
   2. Job-mix Designs: For each job mix proposed for the Work.

B. Material Certificates: For each paving material.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Section 0744 of the 2008 Oregon Standard Specifications for Construction for asphalt paving work.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expect before time required for adequate cure, or if the following conditions are not met:
   1. Tack Coat: Minimum surface temperature of 60 deg F.
   2. Asphalt Base and Surface Course:

Dense Graded Mixes	Surface Temperature
Less than 2 inches	60 degrees F
2 inches – 2 1/2 inches	50 degrees F
Greater than 2 1/2 inches	40 degrees F

   3. If placing asphalt between March 15 and September 30, temperature may be lowered 5 degrees F.
   4. Do not use field burners or other devices to heat the pavement to the specified minimum temperature.

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 for oil based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Conform to the requirements of 00744 of the 2015 Oregon Standard Specifications for Construction.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22 or PG 70-22.

B. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles, or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

C. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
   1. Color: As Indicated.

D. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
   1. Color: As Indicated.

E. Thermoplastic Pavement Markings: Type B-HS Pre-formed, fused thermoplastic film conformed to the requirements of 00867 of the 2008 Oregon Standard Specifications for Construction.
   1. Color: As Indicated.

F. Glass Beads: AASHTO M 247, Type 1.

G. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 6 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
   1. Dowels: Galvanized steel, ¾ inch diameter, 10-inch minimum length.

2.4 MIXES

A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent or more than 30 percent by weight.
   1. Surface Course Limit: Recycled content no more than 30 percent by weight.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:
   1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   2. Provide mixes conforming to section 00744 of the 2015 Oregon Standard Specifications for Construction.
   3. Base Course: Level 2, ½ inch dense, HMAC.
   4. Surface Course: Level 2, ½ inch dense, HMAC.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
   1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply tack coat uniformly to vertical asphalt surfaces. Apply at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

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.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in 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. Spread mix at a minimum temperature of 250 deg F.
   2. 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 wide unless infill edge strips of a lesser width are required.

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 a 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 to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
   4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

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 with vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

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: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 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 asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Cold Milling: Test with a 12 foot (3.7 meter) straightedge furnished and operated by the Contractor, as directed. The variation from the top of the ridges from the testing edge of the straightedge, between any two ridge contact points, shall not exceed 1/4 inch.

B. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

C. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
   4. Difference between adjacent panels: 1/8 inch.

3.8 PAVEMENT MARKING

A. Do not apply pavement-marking paint or thermoplastic material until layout, colors and placement have been verified with architect.

B. Allow paving to age 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.
   1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.9 WHEEL STOPS

A. Install wheel stops with dowels.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.11 WASTE HANDLING

A. Except for material indicated to be recycled, remove excavated materials from Project Site and legally dispose of them in an EPA-approved landfill.

END OF SECTION

CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Driveways.
   2. Roadways.
   3. Parking lots.
   4. Curbs and gutters.
   5. Sidewalks.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed product and for each color and texture specified.

C. 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.

D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Fiber reinforcement
   4. Admixtures
   5. Curing compounds
   6. Applied finish materials.
   7. Bonding agent or epoxy adhesive.
   8. Joint fillers.

E. Minutes of preinstallation conference.

1.3 QUALITY ASSURANCE

A. 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."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301 unless otherwise indicated.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Mockups: Cast mockups of full-size sections of concrete pavement & all finishes to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect and Landscape Architect seven days in advance of dates and times when mockups will be constructed.
   3. Obtain Architect's and Landscape Architect's approval of mockups before starting construction.

4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
5. Demolish and remove approved mockups from the site when directed by Architect.
6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete producer.
d. Concrete pavement subcontractor.

1.4 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

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, smooth exposed surfaces.
1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

C. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

D. Tie bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.
1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dialectric-polymer-coated wire bar supports.

2.3 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 or Type II
a. Fly Ash: ASTM C 618, Class C.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S uniformly graded. Provide aggregates from a single source.
   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. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   3. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

2.4 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.

E. Retardant for Exposed Aggregate: ASTM C494, Type B and D, chloride free, Chem-Masters, L.M. Scofield, or equal. Retardant to be calibrated for aggregate size and finishing requirements.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

G. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements.

2.6 PAVEMENT MARKINGS

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with FS TT-P-115, Type I or AASHTO M 248, Type N.
   1. Color: As indicated.

B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
   1. Color: As indicated.

C. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
   1. Color: As indicated.

D. Glass Beads: AASHTO M247, Type 1.

2.7 DETECTABLE WARNINGS

A. Detectable warnings: ADA truncated domes aligned in a square or radial grid pattern complying with current Accessibility guidelines. Detectable warnings shall be concrete precast pavers.

1. Color: Black or as indicated on Landscape Architect's plans
2. Size: Nominal 12 inch x 12 inch.
3. Thickness: 2 inch.
4. Manufacturers: Cast in Tact.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
   1. Compressive Strength (28 Days): 350 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
   3. Slump Limit: 4 inches, plus or minus 1 inch.
   4. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-inch 25-mm nominal maximum aggregate size.

B. Use a qualified testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

C. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

D. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/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 temperature is between 85 deg F 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 AND PREPARATION

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. Limit vehicle speed to 3 mph.
   2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
   3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Remove loose material from compacted subbase surface immediately before placing concrete.

D. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 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.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

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 pavement, 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. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
   2. Provide tie bars at sides of pavement strips where indicated.
   3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   4. 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.
   5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint or install plastic dowel sleeves per manufacturer's recommendations.

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 isolation 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. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
   7. Fill joint with type A elastomeric sealant per specification section 07 90 05. Sand per landscape plans.

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, 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 grooved marks on concrete surfaces.
   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.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

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. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement 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, placing, and consolidating concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

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, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

I. 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.

J. Screed paving surface with a straightedge and strike off.

K. 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.

L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

O. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   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 mix designs.

P. 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 to 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, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

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.
   2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a ¼ inch (6mm) radius. Repeat tooling of edges after applying surface finished. Eliminate tool marks on concrete surfaces.

3.7 EXPOSED AGGREGATE FINISHING

A. General:
   1. Do not add water to concrete surfaces during finishing operations.
   2. Do not use tools that may force the aggregate away from the surface creating a non-uniform surface after exposure.
   3. Protect all curbs, borders, and adjacent concrete and masonry surfaces, pavers, stones, etc. that are not to receive retarder finish prior to concrete placement and retarder application.

B. Place concrete in the manner described under “Concrete Placement.” Screed or strike off the surface in two (2) directions using a wooden or metal straight edge to achieve the proper elevation in a sawing motion back and forth.

C. Allow the bleed water to evaporate the surface. It can be floated using a wooden hand flaot or a bull-float preferably wooden to close the surface and surround the coarse aggregate with cement paste. Do not overwork the surface, as this tends to drive the aggregate down and away from the surface to be exposed.

D. Float to a uniform appearance. Exposed aggregate to be between ¼" and ½".

E. Follow all retarder manufacturer's recommendations.

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 moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows.
   1. Moist 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 for curing concrete, 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 during 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 subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
   1. Elevation: ¼ inch.
   2. Thickness: Plus 3/8 inch, minus 1/4 inch.
   3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed ¼ inch.
   4. Joint Spacing: ½ inch.
   5. Contraction Joint Depth: Plus 1/4 inch, no minus.
   6. Joint Width: Plus 1/8 inch, no minus.
   7. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
   8. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
   9. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
   10. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete pavement to cure for 28 days and be dry 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.
   1. Spread glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
   4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
   5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
      a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

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 pavement areas with portland cement concrete bonded to pavement 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

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fence framework, fabric, and accessories.
B. Excavation for post bases; concrete foundation for posts.
C. Manual gates and related hardware.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete anchorage for posts.
B. Section 08 71 00 - Door Hardware: Gate locking device.

1.03 REFERENCE STANDARDS
A. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a.
B. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2011.
C. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric; 2011.
D. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2010.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Submittals:
   1. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
   2. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

PART 2 PRODUCTS

2.01 MATERIALS
A. General: Provide all fabric, posts, rails, rods, bars, fittings, and hardware as required to make a complete installation.
B. Posts, Rails, and Frames: ASTM F669 Schedule 40 hot-dipped galvanized steel pipe, welded construction, minimum yield strength of 25,000 psi, with not less than 1.8 oz zinc per sq. ft.
C. Wire Fabric: ASTM A 392 zinc coated steel chain link fabric.
D. Concrete: Type specified in Section 03 30 00.
E. Fittings: All fittings to be hot dipped galvanized pressed steel with not less than 1.2 oz. zinc per sq. ft.

2.02 COMPONENTS
A. Line Posts: 1 7/8 inch outside diameter.
B. Corner and Terminal Posts: 2 3/8 inch outside diameter.
C. Gate Posts: 2 7/8 inch outside diameter with cap.
D. Top, Bottom, and Brace Rail: 1-5/8 inch outside diameter, plain end, sleeve coupled.

E. Gate Frame: 2 3/8 inch diameter for welded gate frame. Gates wider than 48" to have a diagonal brance with turnbuckle. 2 7/8 inch diameter for welded gate from if gate is 6 feet or wider.

F. Fabric: 1.75 inch diamond mesh interwoven wire, 9 gage, 0.1144 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.

G. Tension Bars: 3/16 inch x 3/4 inch x min. 2 inches less than full height of fabric.

H. Tension Wire and Straps: 9 gage thick steel, single strand. Connected to each post with 3/4 inch min. tension band.

I. Tension Band: 3/4 inch at 24 inches on center and 6 inches from top and bottom of fabric.

J. Tie Wire: Aluminum alloy steel wire, 9 gauge minimum. 12 inches on line posts and 24 inches on top rail and tension wire. Wire to be wrapped around fabric 360 degrees min. both ends. Wire ends to be cut flush with fabric, no protrusions.

K. Truss Rods: 5/16 inch outside diameter minimum.

2.03 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: All fittings to be hot dipped galvanized steel with not less than1.2 oz. zinc per sq. ft..

C. Hardware for Single Swinging Gates: Pressed steel industrial butt inges with 180 degree adapters, 2 for gates up to 60 inches high, 3 for taller gates; Industrial fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

D. Hardware for Double Swinging Gates: Pressed steel industrial butt inges with 180 degree adapters, 2 for gates up to 60 inches high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.

E. Panic Hardware: Refer to Architecture for panic hardware on chainlink gates.

2.04 FINISHES

A. Components and accessories: Powder coat all posts, components, and accessories.

B. Fabric: Fabric coating to be ASTM A 817 Type 2 Class 2.

1. Framing coating inside & outside to be ASTM F 1234.

C. Color(s): Black.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F 567.

B. Place fabric on outside of posts and rails, unless indicated otherwise.

1. Match existing fences where new fence abuts.

C. Set intermediate posts plumb, in concrete footings with top of footing 6 inches below finish grade. Slope top of concrete for water runoff.

D. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

E. Provide top rail through line post tops and splice with 6 inch long rail sleeves.

F. Install center brace rail on corner gate leaves.

G. Do not stretch fabric until concrete foundation has cured 28 days.

H. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

I. Position bottom of fabric 2 inches above finished grade.

J. Fasten fabric to top rail, line posts, braces, and bottom rail with tie wire at maximum 15 inches on centers.

K. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

L. Install gate with fabric to match fence. Install hardware.

M. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.02 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From True Position: 1 inch.

END OF SECTION

DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cantilevered gates.

B. Swing gates.

C. Operator.

1.02 RELATED REQUIREMENTS

A. Section 03 33 00 - Cast-in-Place Concrete.

B. Section 08 71 00 - Door Hardware: Hardware for active swing gates.

C. Section 26 05 00 - Common Work Results for Electrical.

D. Division 28 - Electronic Safety and Security.

1.03 REFERENCE STANDARDS

A. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes; 2013a.

B. ASTM B117 - Practice for Operating Salt Spray (Fog) Apparatus; 2011.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.

E. ASTM D523 - Standard Test Method for Specular Gloss; 2008.

F. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint; 2002 (Reapproved 2009).

G. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings; 2013.

H. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments; 2008.

I. ASTM D2244 - Test Method for Calculations of Color Differences from Instrumentally Measured Color Coordinates; 2011.

J. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact); 1993 (Reapproved 2010).

K. ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test; 2009e2.

L. ASTM F2200 - Standard Specification for Automated Vehicular Gate Construction; 2013e1.

M. ASTM F2408 - Ornamental Fences Employing Galvanized Steel Tubular Pickets; 2011.

N. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Shop Drawings:
1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.

D. Installer's Qualification Statement.

E. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

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

B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Finish: 10 years.

PART 2 PRODUCTS

2.01 GENERAL

A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.

B. Extruded Aluminum: ASTM B221, Alloy 6063, Temper T-6.

C. Sheet Aluminum: ASTM B209, Alloy 6063, Temper T-6.

D. Fasteners: ASTM A276, Type 302 stainless steel; finished to match fence components.
1. Tamper-proof security bolts.
2. Self-drilling hex-head screws.

2.02 ALUMINUM FENCE

A. Decorative Aluminum Swing Gates:
1. Type: Double leaf swing.
2. Gate Panels: Manufacturer's standard decorative aluminum fence panels; 100 percent direct visual screening' inclined, flanged louver blades to match cantilevered gate.
a. Similar to Total Eclipse Panel by Ametco Manufacturing Corp.
3. Posts: Aluminum extrusions; 2 inches square.
4. Rails and Frame: Welded aluminum extrusions; 2 inches by 3 inches.
5. Hardware:
a. Hinges: Heavy duty pivot type; minimum 4 per leaf.
b. Latch: At small active leaf as specified in Section 08 71 00 - Door Hardware.
c. Bolt: Cane bolt at large inactive leaf.
6. Size: As indicated on Drawings.

7. Operation: Manual.
8. Color: To match Kawneer Permanodic Dark Bronze No. 40.
9. Product:
    a. Swing Gate System by Ametco Manufacturing Corp.: www.ametco.com.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

B. Decorative Aluminum Cantilever Gates:
1. Type: Cantilever sliding single leaf.
2. Size: As indicated on Drawings.
3. Gate Panels: Manufacturer's standard decorative aluminum fence panels; 100 percent direct visual screening; inclined, flanged louver blades.
    a. Similar to Total Eclipse Panel by Ametco Manufacturing Corp.
4. Posts: Aluminum extrusions; 2 inches square.
5. Rails and Frame: Welded aluminum extrusions; 2 inches by 3 inches.
6. Hardware:
    a. Latch: Manufacturer's standard mechanism; factory finished galvanized steel.
    b. Truck assembly: Manufacturer's standard, self-aligning, wheeled truck assembly supporting weight of gate plus 2,000 pound reaction load; provide number of truck assemblies per gate recommended by manufacturer.
    c. Guide wheel assembly: Manufacturer's standard, adjustable, dual wheel assembly; provide number of guide wheels per gate recommended by manufacturer.
7. Operation: Automatic.
8. Color: To match Kawneer Permanodic Dark Bronze No. 40.
9. Products:
    a. Monorail Track Cantilever Gate by Ametco Manufacturing Corp.: www.ametco.com.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 GATE OPERATOR

A. Type: Single sliding gate operation; one operator per each sliding gate leaf. Comply with UL 325, Class III and ASTM F2200.

B. Description: 1/2 hp, minimum; right angle gearhead instantly reversing motor, NEMA rated starter, magnetic brake, safety disc clutch and chain driven gear type automatic limit switch.

C. Connection: 230 volt, 3-phase.

D. Products:
1. Aut-o-dor Model 1295 by Crown Industrial Operators: www.crown-industrial.com.
2. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 FINISHES

A. Electro-Deposition Coating: Multi-stage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
1. Total Coating Thickness: 2 mils, minimum.
2. Color: Custom color as selected by Architect.
3. Coating Performance: Comply with general requirements of ASTM F2408.
    a. Adhesion: ASTM D3359 (Method B); Class 3B with 90 percent or more of coating remaining in tested area.
    b. Corrosion Resistance: ASTM B117, D 714 and D 1654; 1/8 inch coating loss or medium No.8 blisters after 1,500 hours.
    c. Impact Resistance: ASTM D2794; 60 inch pounds.
    d. Weathering Resistance: ASTM D523, D822/D822M and D2244; less than 60 percent loss of gloss.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set fence posts in accordance with the manufacturer recommended spacing.

C. When cutting rails immediately seal the exposed surfaces by:
   1. Removing all metal shavings from cut area.
   2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
   3. Apply 2 coats of custom finish spray paint matching fence color.
   4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
   1. Base type and quantity of gate hinges to fit the application; weight, height, and number of gate cycles.
   2. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
   3. Provide gate hardware by the manufacturer of the gate and install per manufacturer's recommendations

3.03 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From Indicated Position: 1 inch.

C. Minimum distance from property line: 6 inches..

3.04 CLEANING

A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

B. Clean fence with mild household detergent and clean water rinse well. .

C. Touch up scratched surfaces using materials recommended by manufacturer. Match touchup paint color to fence finish.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 32 80 00
IRRIGATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Irrigation System.
B. Backflow Prevention Assembly and related appurtenances.
C. Central Control system, control wires, shrub and lawn zones.

1.02 RELATED REQUIREMENTS

A. Section 01 56 39 - TEMPORARY TREE AND PLANT PROTECTION
B. Section 01 60 00 - Product Requirements
C. Section 01 79 00 - Demonstration and Training
D. Division 26 - Electrical
E. Division 31 - Earthwork
F. Section 32 90 00 - Planting

1.03 REFERENCE STANDARDS

A. ASTM D1784: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
B. ASTM D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
C. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
D. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
E. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004 (Reapproved 2009).

1.04 PROTECTION

A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave area in similar condition as found.
B. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities at Contractor's expense.
C. Use means necessary to protect materials of this Section before, during, and after installation and to protect installed Work and materials of other trades. In the event of damage immediately make repairs and replacements as directed by Owner's Representative.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with other trades affecting and affected by Work of this Section.
B. Preinstallation Meeting: Convene one week (minimum) prior to commencing work of this Section to coordinate utility marking procedures.

1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Submit manufacturer's printed data covering products and installation instructions.

C. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with irrigation work, description of irrigation system, and Owner's contact information.

D. Record Documents: Record actual locations of installed irrigation components on a clean set of plans. Use white out and red ink to legibly re-draft as-built information.
   1. Produce and keep current throughout the project.
   2. Indicate two dimensions for valves, stub outs, and main line T's, L's, ends, elbow's, and change in direction.
   3. Submit to Owner's Representative for approval.

E. Operation and Maintenance Data:
   1. Provide written instructions at System Demonstration for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's parts catalog.
   2. Submit chart showing actual precipitation rates for each zone.
   3. Prepare a program for the irrigation controller for Spring/Summer; Summer; Summer/Fall using historical weather data and averages. Include start times, watering duration, day of week, repeat cycle mode, program mode, precipitation rates in inches per hour, and application quantities. Coordinate operation and programming with Owner's Representative.

F. Maintenance Materials: Provide the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Valve Keys for Manual Valves: One.
   3. Extra Valve Box Keys: One.
   4. Wrenches: One for each type head core and for removing and installing each type head.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing Work of this Section who has successfully completed a minimum of 5 comparable scale projects and have the following licenses:
   1. For Irrigation Work:
      a. Valid Oregon Landscape Contractors license.
      b. Valid Oregon Landscape Business license.
   2. For Plumbing Work:
      a. Valid Oregon Plumbing license.
      b. Valid Oregon Landscape Contractor license.
   3. Successfully completed at least 5 comparable scale projects.
      a. Submit names, addresses, dates, owners and locations of previous projects if requested by Owner’s Representative.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in original unopened packaging with legible manufacturer's identification.

B. Comply with manufacturer's recommendations for storage and protection.
   1. Store in a cool, dry place out of direct sunlight.
   2. Protect from damage by the elements and construction procedures.
   3. Store plastic pipe on firm, level supports.
   4. Store plastic pipe cement in cool location.

1.09 ENVIRONMENTAL CONDITIONS

A. Temperature of mating surfaces of plastic pipe and fittings to be between 40 degrees fahrenheit and 100 degrees fahrenheit. Perform no PVC Solvent welding in rainy weather except under cover.

1.10 REVIEWS

A. Request the following reviews by the Owner's Representative two days (min.) in advance:
   1. Irrigation Head Layout Review
   2. Pressure Test and Mainline Installation
   3. System Review
   4. System Demonstration to Owner

B. Coordinate Reviews to coincide with regular progress meetings where possible.

1.11 MAINTENANCE

A. During period between system installation and Final Acceptance provide maintenance to assure proper operation of the irrigation system.

1.12 WARRANTY

A. Warranty period shall be one year following Final Completion or one full operating season following Final Completion, whichever is longer.

B. Contractor guarantees materials furnished under this Contract will be as specified and the Work will be free of defects in compliance with the Contract Documents.

C. Irrigation system must be in proper working condition at the end of the warranty period. At no additional cost to the Owner replace Work of this Section as necessary to restore system to proper working condition following the Contract Documents.

D. Visit and inspect Work at least once a month during warranty period and notify Owner's Representative in writing of any observed conditions requiring attention. Failure to provide such notification renders deficiencies the Contractor's responsibility to rectify.

E. Contractor is not responsible for loss or damage to Work of this Section caused by unusually extreme weather, vandalism, or lack of Owner's maintenance during warranty period.

PART 2 PRODUCTS

2.01 IRRIGATION SYSTEM MATERIALS

A. Use only new materials of brands and types shown on Drawings or specified herein.

B. Similar materials must be products of one manufacturer unless otherwise approved.

C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PIPE MATERIALS

A. Mainline Pipe, Lateral Line Pipe and Irrigation Sleeves: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.

B. Risers: One piece schedule 80 gray PVC Pipe, Type 1, threaded at both ends conforming to ASTM D1784 and ASTM D2464. No snap-risers.

C. Swing Joint Assembly Pipe and Fittings: Double swing joint risers as detailed. Swing-Pipe, snap, and "Funny pipe" risers not acceptable.

D. Flex Riser Assembly: 18 inch minimum, 3 feet maximum Swing-Pipe with transfer barb 90 degree ells at both ends and a marlex ell below the irrigation head.

E. Electrical Conduit and Fittings:
   1. Underground: Plastic, Class 3, Federal Specification W-C-1094.
   2. Above Ground: Aluminum, Federal Specification WW-G-540.

F. PVC Solvent Cement: NSF approved solvent for Class 1245-B&C PVC through 4 inches conforming to ASTM D 2564 for PVC pipe and fittings. Ensure that manufacturer's expiration date is not exceeded.
   1. IPS Corporation Weld-on #704 or #711.

G. PVC Cleaner and Primer:
   1. IPS Corporation Weld-on P-70 or as recommended by PVC Pipe manufacturer.

2.03 VALVES

A. Isolation Valves - 3 inch and under: Threaded gate valve with resilient wedge sized to match mainline with brass wheel handle.
   1. Approved Products:
      a. Kennedy model 8057, or approved.

B. Control Valve Assembly:
   1. Automatic Control Valve: Globe type, 200 psi rated, threaded connections with cross type operating handle designed to receive operating key. Size according to Valve Schedule on Drawing.
      a. Approved Products:
         1) Rain Bird PEB-PRS-D Series.
   2. Shut Off Valve: USA manufactured gate valve. 135 psi cold water rated constructed of brass or bronze on 2 inch and under valves with bronze wheel handle.
      a. Approved Products:
         1) Nibco T-113

C. Quick Coupling Valves:
   1. Approved Products:
      a. Rain Bird 44 RC.

D. Master Valve: 24V AC, normally open and flanged at both ends.
   1. Approved Products:
      a. Size: 2 inch.
      b. By Superior Manufacture.

E. Flow Sensor: PVC tee type sensor.
   1. Approved Products:
      a. Model FSI-T20_001 by Creative Sensor Technology.

F. Manual Drain Valve: Globe or angle brass manual valve with non-floating seat disk that allows positive drainage.
   1. Approved Products:
      a. Manufactured by Champion.

G. Backflow Preventers: Double check valve assembly.
   1. Approved Products:
      a. Size: 3 inch.
      b. Model # 805YD by Febco.

2.04 VALVE BOXES

A. Valve box of suitable size with tee top type lid .
   1. Black box and lid in plant bed areas.
   2. Black box and green lid in lawn areas.
   3. Green box and lid.
   4. Black box and green lid at lawn areas.
   5. Black box and brown lid at plant bed areas.

B. Install valves in the following valve boxes:
   1. Control Valve Assembly: (2) Rain Bird VB-STD, T-Lid.
   2. Quick Coupling Valves: Carson 910-18, T-Lid.
   3. Manual Drain Valves: Carson 910-18.
   4. Isolation Valves: Carson 910-10.
   5. Other Valves: Sized as applicable by Carson.

2.05 IRRIGATION HEADS

A. Makes and models shown on Drawings, or approved.

2.06 WIRE

A. Zone Control Wire: Install according to manufacturer's wire schedule for valve specifications. 14 gauge minimum, type AWG-UF, bearing U.S. approval.

B. Wire Connections: Direct bury splice Kit.
   1. DBR/Y by 3M.
   2. Scotch Lok 3570.

C. Utility Locate Wire: 14 gauge minimum, type AWG-UF, bearing U.S. approval, blue in color.

2.07 IRRIGATION CONTROLLER

A. One (1) Commercial Series, ESP-24SAT-W, Maxicom Central Irrigation Controller by Rain Bird.

B. One (1) Commerical Series, ESP-40SAT-W, Maxicom Central Irrigation controller by Rain Bird

C. See Drawings for Location.

2.08 BACKFILL MATERIALS

A. Pea Gravel: 3/4 x 1/2 inch washed round rock.

B. Sand: Clean, fill sand free of clay, rocks, organic matter, or other deleterious material.

C. Topsoil or Loam: See Section 31 20 00 - Earth Moving.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that required utilities and sleeves are available, in proper location, and ready for use. Verify location, type, size, psi, and GPM of existing water lines, meters, and sleeves.

B. Verify that surfaces and structures to receive Work are accurately sized and located, sound, secure, true, complete, and otherwise properly prepared.

C. Verify electrical service and conduit for Irrigation Controller is properly sized and located.

3.02 PREPARATION

A. System layout is diagrammatic. Route piping to avoid plants, ground cover, and structures. If field measurements differ slightly from Drawings modify work for accurate fit. If measurements differ substantially notify Owner's Representative prior to installation.

B. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system and piping to minimize conflict with other work.

C. Coordinate connections to existing irrigation system, including system shut down, new connections, system re-start, and scheduling of new irrigation zone run times with Owner's Representative.

D. Irrigation Head Layout Review: Install flags at locations of irrigation heads and components shown on Drawings. Obtain Owner's Representative's approval and make adjustments to locations as directed. Coordinate marking of pipe trenches and location of valves prior to executing Work.

3.03 CUTTING OF PAVEMENT AND REPAIR

A. Do no cutting of pavement for installation of Work without Owner Representative's approval.

3.04 BACKFLOW PREVENTION DEVICE INSTALLATION

A. Install where shown on Drawings. Follow applicable codes and in accordance with manufacturer's directions when making supply and central contol component connections. Coordinate with other trades.

B. Coordinate connection with other trades.

3.05 MASTER VALVE AND FLOW SENSOR INSTALLATION

A. Install where shown on Drawings in accordance with manufacturer's directions when making supply and central control component connections.

3.06 TRENCHING

A. Excavate trenches with uniform bottom and remove rocks and sharp objects to provide firm, even, clean base for pipe. Width of trench to be 1.5 times the outside diamter of the pipe.

B. Trench Depth:

1. Minimum Cover Over Installed Mainline Piping: 24 inches.
2. Minimum Cover Over Installed Lateral Line Piping: 18 inches.
3. Minimum Cover Over Installed Sleeves in Roadway: 24 inches.
4. Minimum Cover Over Installed Sleeves at other paving: 6 inches from bottom of paving.

C. More than one pipe is permitted in the same trench provided that:

1. Two pipes may be stacked vertically if 4 inches of Sand separates them.
2. Three or more pipes must be laid 4 inches apart horizontally.

D. Where excavation is performed to excess levels backfill with Sand to proper levels.

E. Keep trenches dry and frost free. Provide and operate pumping equipment to keep excavations free from standing water.

F. Protect existing vegetation to remain. Cut no roots over two inches in diameter without approval of Owner's Representative. Make cuts clean, straight, at right angles to roots. Paint cuts over 1-1/2 inches diameter with approved tree paint. Repair or replace damaged plant material.

3.07 SLEEVE INSTALLATION

A. Sleeves may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fills where there is potential for damage to pipes.

B. Extend sleeves 12 inches beyond pavement edge or curb.

C. Install level and perpendicular to sidewalks and pavement unless shown otherwise on drawings.

D. Provide markers where sleeve ends are concealed.

3.08 PIPE BEDDING

A. Mainline: Provide uniform bearing surface of Sand, 4 inches minimum depth, free of rocks and sharp objects under entire length of pipe.

B. Lateral Line: Provide uniform bearing surface of clean topsoil, loam, or Sand. If rock or other deleterious materials are encountered bed pipe with 4 inches of Sand on all sides.

3.09 PIPE INSTALLATION

A. Irrigation lines may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fill or where there is potential damage to pipes.

B. Install pipe in accordance with manufacturer's instructions and with the following minimum clearances around pipe:

1. 2 inch diameter and smaller: 2 inches

2. 2-1/2 inch diameter and larger: 4 inches
3. Between irrigation and other utilities: 1 foot

C. Threaded Plastic Pipe Installation:
1. Do not use solvent cement on joints.
2. Wrap threaded joints with teflon tape. Minimum 4 wraps of tape.

D. Cemented Plastic Pipe Installation:
1. Cut ends square using approved pipe cutter and bevel cuts with deburring tool.
2. Clean pipe of scale, sand, dirt, etc. prior to assembling.
3. Avoid using an excess amount of primer and cement when making joints; particularly on the inside of female pipe ends and fittings.
4. Wipe off excess cement continuously as it appears on the surface of the pipe after making joints.
5. Allow fifteen minutes of cure time on joints before moving or handling. Assemble pipe before lowering into trench.
6. Snake lines to allow for contraction.
7. Transition pipe sizes at fittings and not bell end of pipes.
8. Install thrust blocks at 90 degree corners and tees.

3.10 THRUST BLOCK INSTALLATION

A. Install 2500psi thrust block at pipe corners, tees, ells, and stub outs.
1. Pipe 2 - 3 inches in diameter: 1 cubic foot.
2. Pipe larger than 3 inches in diameter: 2 cubic feet.

3.11 VALVE INSTALLATION

A. Install plumb and square, as detailed, and according to manufacturer's specifications.

B. Manual Drain Valves:
1. Install at mainline low points and at outlet of control valves where laterals run uphill.
2. Record locations on as-built drawings.

C. Install 1 valve in each valve box assembly.

D. Valve Sump: Install a minimum of 2 cubic feet of Pea Gravel below each valve. Allow for 4 inches clearance between bottom of valve and valve sump.

3.12 VALVE BOX INSTALLATION

A. Install plumb and square with adjacent construction with one valve in each valve box assembly.

B. At Control Valve Assemblies bolt two valve boxes together as detailed.

C. Permanently label valve type and zone number on inside of valve box lid.

D. Set top of valve boxes flush with lawn or mulch at plant beds unless otherwise noted.

E. Provide 12 square inches (min.) of support on each side of valve box as detailed.

3.13 CONTROL WIRE INSTALLATION

A. Install wires below irrigation mainline with multiple wires bundled together at 5 foot maximum intervals in a continuous run. Notify Owner's Representative for approval prior if splices are required and locate in valve box.

B. Use coded and labeled wires for each valve. Provide a numbered tag at each end of a wire at valve, and at controller. The number at each end of wire to be the same.

C. Provide 48 inches loop in wires at each valve where controls are connected and at 100 foot maximum intervals between. Coil wire around 1/2 inch rebar dowel inside of valve box.

D. Make electrical joints waterproof using specified connectors. Enclose joints in valve boxes.

E. Install wire in continuous runs with no splices unless approved.

F. Show wire routes and approved splice locations on As-Built drawings.

G. Install wires above grade or independent of the mainline in conduit.

3.14 CONTROLLER INSTALLATION

A. Install controller in accordance with manufacturer's specifications and applicable codes. Connect to 120V power supply at location shown on drawings and approved by Owner's Representative.

3.15 IRRIGATION CONTROL ASSEMBLY INSTALLATION

A. Install Irrigation Control Assembly in accordance with manufacturer's specifications and applicable codes. Connect to 120V power supply at location shown on drawings and by Owner's Representative.

3.16 MAINLINE PRESSURE TEST AND INSPECTION

A. Field inspection and testing will be performed under provisions of Section 01 40 00.

B. Prior to backfilling and installing valves test irrigation mainline for leakage. Establish and maintain 100 psi pressure for 24 hours. Perform test a minimum of 24 hours after set-up of solvent weld. Notify Owner's Representative a minimum of 24 hours for review of pressure gauge at beginning and end of test period. Mainline will be accepted if pressure loss is less than 2 psi.

C. Following the pressure test but prior to backfilling, notify Owner's Representative for review of pipe, fittings, joints, thrust blocks, bedding, control wire installation, valves, and other materials for installation and water tightness.

D. After successful pressure test and mainline inspection begin backfilling and assembly of zones and system components.

3.17 BACKFILLING

A. Remove debris, sharp rocks, and decayable matter from areas to be back filled before proceeding.

B. Main Lines: Provide 6 inch Sand cover over piping then place Utility Locate Wire the entire length of pipes where control wires are not present. Backfill remainder of trench with Topsoil or Loam.

C. Lateral Lines: Backfill trench with Topsoil or Loam. Protect piping from displacement.

D. At Paved Areas: Backfill trench with Sand under paved areas.

E. Compact backfill in 6 inch lifts to match density of surrounding material. Install backfill to match adjacent elevations.

3.18 FLUSHING

A. Mainline: Open valves and thoroughly flush piping system under full water head after piping, risers, and valves are installed. Maintain flushing for three minutes. Close valves and cap risers immediately after flushing.

B. Second Flushing: Flush a second time after installation of lateral lines and sprinklers prior to nozzle installation. Flush under full water head for three minutes. Install nozzles after flushing.

C. Drip Line Flushing: Remove flush cap and flush each zone under full water head after all connections have been made. Maintain flushing for three minutes and immediately replace flush cap.

3.19 SPRINKLER HEAD INSTALLATION

A. Install plumb with top of Topsoil/Loam or Mulch as detailed and at locations shown on drawings. Allow a maximum of 3 inches clearance between sprinkler head and adjacent lawn or planting edge.

B. Install 1 cubic foot Pea Gravel sump on all low irrigation heads where drainage occurs at zone shutdown.

3.20 SYSTEM REVIEW

A. Prepare and start system in accordance with manufacturer's instructions. Prior to notifying Owner's Representative for review of the system review zones and make adjustments to ensure full and even coverage.

B. Notify Owner's Representative for review of system operation to determine if water afforded to all areas is complete, adequate, and uniform.

C. Adjust system for full water coverage as directed.

3.21 SYSTEM DEMONSTRATION TO OWNER

A. Instruct Owner's personnel in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance data as basis for demonstration.

3.22 CLEANING

A. Remove excess excavation, backfill materials, and other left over materials from the site. Clean improvements soiled by Work of this Section.

END OF SECTION

SECTION 32 90 00

PLANTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil.
B. Soil Material placement.
C. Accent Stones.
D. Drain rock placement.
E. New trees, plants, and ground cover.
F. Mulch and Fertilizer.
G. Maintenance.

1.02 RELATED REQUIREMENTS

A. Section 01 56 39 - Temporary Tree and Plant Protection.
B. Section 01 60 00 - Product Requirements.
C. Section 01 70 00 - Execution and Closeout Requirements.
D. Section 31 20 00 - Earth Moving.
E. Section 32 80 00 - Irrigation.

1.03 DEFINITIONS

A. Weeds: Any plant life not specified or scheduled. Includes seeds and roots.
B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.04 REFERENCE STANDARDS

A. Quality definitions, grading tolerances, root system condition, caliper height, branching, budding: ANSI/ANLA Z60.1 - American Standard for Nursery Stock, latest edition.
B. ANSI A300 Part 1 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices; 2001.
C. Nomenclature conforms to "Standardized Plant Names," 1942 Edition, published by J. Horace McFarland Co., or "New Sunset Western Garden Book," listed in these references are those used most commonly in the nursery trade.

1.05 PROTECTION

A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave in similar condition as found.
B. Maintain benchmarks, monuments, and other reference points. Replace if disturbed or destroyed.
C. Contact local utility companies for verification of the location of underground utilities within the project area prior to starting excavation. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities or related facilities in an approved manner at Contractor's expense.
D. Protect drainage inlets and underground drain lines from infiltration or clogging by soils and mulch during construction until Final Completion.
E. Protect materials of this Section before, during, and after installation. Protect installed work and materials of other trades. In the event of damage immediately make repairs or replacements as directed by Owner's Representative.

1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Maintenance Data: Include written instructions covering yearly recommended maintenance and care of plantings including fertilization, pest and disease control, weed control, mulching, and pruning.

C. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with planting work, and Owner's contact information.

D. Submit list of plant life sources within 14 calendar days of Agreement Date.

1. Submit confirmation from supplier(s) that specified plant materials, meeting the specifications, have been secured.
2. Include plant name, quantity, size, condition, and name of supplier.
3. Submit certification letter from the sod supplier(s) stating the sod has been secured or contracted for delivery. Include the quantity, grass mix, and description.

E. Product Data: Submit manufacturer's printed data for products and a list of suppliers.

F. Invoices: Within 2 days of delivery submit invoices, load tickets, and truck measures for Organic Material and Mulch.

1.07 QUALITY ASSURANCE

A. Valid Oregon Landscape Contractor's license.

B. Valid Oregon Landscape Business license.

C. Installer Qualifications: Company specializing in installing and planting the plants with 5 projects of comparable scale successfully completed.

1. Submit names, addresses, and dates of previous projects, owners.

1.08 COORDINATION

A. Coordinate with other trades affecting and affected by Work of this Section.

B. Pre-Installation Conference: Attend conference to coordinate Work of this Section and other related Sections.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Protect and maintain plant life until planted.

C. Deliver plant life materials immediately prior to placement. Keep plants moist.

D. Deliver products in original unopened packaging with legible manufacturer's identification.

E. Seed containers shall show manufacturer's guaranteed analysis of seed mixture, percentage of purity, year of production, date and location of packaging, name and trademark, and conformance with governing regulations.

F. Plants may be rejected if:

1. Ball of earth surrounding roots has been dried out, cracked, or broken.
2. Burlap, staves, wire baskets, or ropes required in connection with transplanting have been displaced.
3. Grower or nursery identification labels have been displaced prior to acceptance.

1.10 ENVIRONMENTAL CONDITIONS

A. Do not install plant life and seed when ambient temperatures is below 32 degrees F or above 90 degrees F.

B. Do not install plant life when wind velocity exceeds 30 mph.

C. Do not install plant life when soil becomes saturated.

D. Install plant materials and seed during periods which are normal for such work as determined by the following:
   1. Biological season
   2. Specified environmental conditions
   3. Accepted practice
   4. After all major construction work has been completed

E. Planting Seasons:
   1. Trees: Bare root trees may be planted only between January 15th and March 15th unless otherwise approved.
   2. Seeding: Permitted between April 15 and October 15 unless otherwise approved.
   3. Other: Permitted during any period, except when prohibited by other portions of this Section.

1.11 REVIEWS

A. Request the following reviews by the Owner's Representative 2 days in advance:
   1. Subgrade preparation
   2. Soil Material placement
   3. Organic Material placement
   4. Finish grading
   5. Accent stone mock-up
   6. Accent stone placement review
   7. Plant materials
   8. Plant material layout
   9. Planting mock-up
   10. Completion

B. See Part 3 - Execution for review requirements.

C. Coordinate all reviews to coincide with regular progress meetings where possible.

1.12 RECORD DOCUMENTS

A. See Section 01 78 00 - Closeout Submittals

B. Produce, keep current, and submit legible record documents on a clean set of plans and details supplied by the Owner's Representative. Use white-out and red ink to legibly re-draft actual locations of installed work.

1.13 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide one year warranty following Final Completion or one full growing season following Final Completion, whichever is later.

C. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

D. Inspection: Visit work at least once a month during warranty period. Notify Owner's Representative and Owner in writing of any observed conditions requiring attention. Failure to provide such notification renders any deficiencies the Contractor's responsibility to rectify.

E. At the end of the warranty period, as directed by Owner's Representative and at no additional cost to the Owner:
   1. Replace work not surviving, in poor condition, or not exhibiting satisfactory growth.
   2. Lawns must be healthy, dense, uniform, well sodded, and reasonably weed free as judged by the Owner's Representative.
   3. Reset plant materials and stones which have settled or become un-set

4. Replace plant materials which appear to be a different species or variety than specified.
5. Provide noxious weed eradication from imported Soil Material, if required and as specified herein.
6. Complete warranty work within 30 days of warranty review.

F. Contractor is not responsible for plant loss or damage to work during warranty period which is caused by unusually extreme weather, vandalism, or Owner's lack of maintenance.

PART 2 PRODUCTS

2.01 PLANTS

A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

B. General:
1. Sizes, grades, and conditions are listed on Plant List. Quantities are shown for Contractor's convenience. Contract is responsible for providing plants drawn on drawings.
2. Cold storage stock unacceptable.
3. Free of disease, decay, injury, insects, or indication of strawberry root weevil.
4. Full foliaged when in leaf.
5. Furnish balled and burlapped (B&B) stock with solid, properly wrapped and secured, natural ball. Stock 2 inch caliper and up to be transported and handled with root ball in wire basket.
6. Furnish container stock with sufficient roots to insure healthy growth but not root bound. When plant is removed from container soil must hold together and roots must be visible but not encircling.
7. Free from Weeds.
8. Field grown trees and shrubs must have been transplanted or root pruned at least once no more than two years prior to this Contract.
9. Container stock may be substituted for Balled and Burlapped (B&B) stock at any time.

C. Trees shall have:
1. Single, straight, uniformly tapering trunks which are perpendicular to the ground, unless specified as multi-stemmed or otherwise on Plant List. Trees with co-dominant, damaged, crooked, or topped leaders will be rejected.
2. Healthy and vigorous overall condition.
3. Full and even branch distribution; structural scaffold branches at least 4 inches apart where they attach to the main trunk.
4. Well developed root systems. Trees with more than 2 inches of root ball soil covering root flare will be rejected.
5. Grafts near ground level.
6. Minimum/maximum branching heights above the ground unless specified otherwise on Plant List:
   a. 2 inch caliper tree: 5' - 7'
   b. 1.5 inch caliper tree: 4' - 6'
7. Conifers shall also have full, even branching to ground level and intact single leader.
8. Trees shall be free of:
   a. Major structural defects including, but not limited to, branches with narrow angle of attachment (less than 40 degrees to the trunk), bark with major branch unions, and trees with co-dominant leaders.
   b. Poor pruning practices including, but not limited to, stubbed branches and topped leader.

c. Damage to the trunk, branches, and root system including, but not limited to, bark abrasions, sun scald, and disfiguring knots.

9. Trees shall be freshly dug during the most recent favorable harvest season.

2.02 SOIL MATERIALS

A. Planting Soil: On-site soil, natural, fertile, friable, with at least 10% humus; free of rock, clay, subsoil, clods, lumps, plants, roots, sticks, weeds, seeds, and other deleterious material, as approved.

1. At Plant Beds:
   a. Excavated from site. Stock piled on-site.
2. At Stormwater Planters:
   a. See Specification Section 31 20 00 for soil and compost.
3. At Lawns and Eco Lawns:
   a. Excavated from site. Stock piled on-site.

2.03 SOIL AMENDMENT MATERIALS

A. Lawn Installation Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:.

1. Nitrogen: 16 percent. (source of Nitrogen to be methyl-urea based)
2. Phosphoric Acid: 16 percent.
3. Soluble Potash: 16 percent.
4. Do not use within 50 feet of water.

B. Lawn Maintenance Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:.

1. Nitrogen: 25 percent. (30% Nitrogen from slow release)
2. Phosphoric Acid: 5 percent.
3. Soluble Potash: 10 percent.
4. Do not use within 50 feet of water.

C. Plant Bed Maintenance Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:.

1. Nitrogen: 16 percent. (Source of Nitrogen to be methyl-urea based)
2. Phosphoric Acid: 16 percent.
3. Soluble Potash: 16 percent.
4. Do not use within 50 feet of water.

D. Planting Tablets:

1. Product: Sierra Chemical "Agriform" with 20-10-5 chemical analysis.
2. Substitutions: See Section 01 60 00 - Product Requirements.

E. Micorrhizal Fungi:

1. MycroApply® All Purpose Granular by Micorrhizal Applications Inc, Grants Pass, Oregon (541-476-3985).
2. Substitutions: See Section 01 60 00 - Product Requirements.

F. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

G. Organic Material: 100% organic materials following guidelines and tested to meet the US Composting Council's seal of testing assurance.

1. Products: Garden Compost by Rexius Forest Byproducts, Eugene, Oregon.

H. Top Dressing: Turf Start by Rexius Forest Byproducts, Eugene, Oregon, or approved.

2.04 ACCENT STONES

A. Basalt stones in 2 distinct sizes:
   1. Medium Stone: Length 24"-30" x Width 18"- 24" x Height 12"-18"
   2. Small Stone: Length 18"-24" x Width 14"- 18" x Height 10"- 14"

B. Clean, hard, durable rounded river stones, with no broken fragments, in a range of natural colors. Provide accent stones from a single source in the Willamette Valley. Provide color photo inidcating sample of eight accent stones of assorted colors, indicating source of material. Provide accent stones in the following four 4 distinct sizes:

C. Approved Suppliers:
   1. Oakridge Quarry, Berry St. Oakridge, Oregon.
   2. Premium Landscape Stone by Mid Valley Gravel Company, Philomath, Oregon (541-929-2200).
   3. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 GRASS SEED

A. Certified Oregon Blue Tag Free of Weed seed with dealer's statement analysis guarantee.

B. Current or latest season's crop labeled in conformance with State and US Department of Agriculture laws and regulations:
   1. Purity: 98% by weight
   2. Germination: 90%

C. Products:
   1. Lawn Seed:
      a. Futura 3000 by Pickseed, Tangent, Oregon
   2. Eco Lawn Seed:
      a. Pro-Time 705 PDX Ecology Mix by Hobbs and Hopkins, Portland, Oregon.

2.06 MULCH MATERIALS

A. Mulching Material at Plant Beds Type 1 & Type 2: Hemlock species wood shavings, free of growth or weeds, "sliver free".
   1. Products: Hemlock Bark by Rexius Forest Byproducts, Eugene, Oregon, or Lane Forest Products.

B. Basalt Quarry Rock Mulch at Stormwater Planters:
   1. River Rock Mulch at Stormwater Planters:
      a. Products: 3/4" - 1/4" washed, open quarry rock.

2.07 ACCESSORIES

A. Wrapping Materials: Burlap.

B. Stakes: 2 x 2 inch x 8 feet wood stakes, capable of at least 2 years ground burial, stained charcoal or black.

C. Tree Ties: Chain lock tree ties, 1 inch wide, or approved.

2.08 HERBICIDE

A. No herbicide use allowed.

2.09 METAL LANDSCAPE EDGE AND STAKE

A. 3000 Series Landscape Edge by Curv-Rite, Inc., 1-800-366-2878, or approved.
   1. Size: 1/8" x 5 1/2" x 16'.
   2. Color: Mill Finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to installation of Work of this Section, carefully inspect the work of others and verify that such work is complete to the point where this installation may properly commence.

B. Verify that materials and surfaces to receive work specified herein are accurately sized, shaped, and located; sound, secure, true, complete, and otherwise properly prepared.

C. Verify subgrades produce positive drainage and allow for placement of Soil Material, Ammendments, and Mulch to specified depths.

D. Do not install Work of this Section until all unsatisfactory conditions have been corrected. Beginning Work of this Section signifies acceptance of existing conditions.

3.02 TOLERANCES

A. Perform earthwork true to lines and grades, and to prevent ponding of water, with maximum variation in elevations of +/- 1/2 inch at subgrades and +/- 1/4 inch at finish grades.

B. Compacted thickness of materials within 1/4 inch of specified thickness.

3.03 PREPARATION OF SUBGRADE

A. Prepare subsoil to eliminate uneven areas or low spots. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots, stones, rock, and dirt clods. Remove contaminated subsoil.

C. Scarify subsoil to a depth of 6 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

D. Verify subgrades, whether comprised of subgrade soil or fill drain freely. Test area by flooding with Owner's Representative present. Where water does not drain freely auger a 10 inch hole, minimum 1 per 1,000 square feet, through fill material and into subsoil, or minimum 4 feet deep into subsoil to establish positive drainage.

E. Verify subgrades allow for placement of Soil Material, Amendments, and Mulch to depths specified.

F. Notify Owner's Representative for Subgrade Preparation Review prior to placing Soil Material.

3.04 PLACING SOIL MATERIAL

A. Soil Placement Schedule:

1. At Plant Beds: 18 inches minimum depth.
2. At Lawns: 9 inches minimum depth.
3. Reinforced Lawn at Fire Lane: As detailed.
4. At Eco Lawn: 9 inches minimum depth.
5. At Grassy Swales: Refer to Civil.
6. Place additional Soil Material as required to establish finish grades shown on drawings and to fill in depressions, blend grades, and produce positive drainage.

B. Place Soil Material during dry weather and on dry unfrozen subgrade. Suspend Soil Material placement if subgrade or Soil Material become saturated.

C. Phase Soil Material placement so that equipment does not travel over Soil Material already installed.

D. Place Soil Material in a relatively dry state to depths specified at locations shown on Drawings:

1. Remove stones, roots, grass, weeds, debris, and foreign material while spreading.
2. Manually spread around existing trees, paving, and other structures to prevent damage.
3. Establish levels, profiles, slopes, contours, and uniform gradients between given grade points as shown on Drawings.

4. Eliminate uneven or low spots at lawns and plant beds.
5. Fine grade Soil Material within specified tolerances.

E. Notify Owner's Representative for Soil Material Placement Review prior to proceeding with Work.

3.05 INITIAL WEED CONTROL

A. Inspect plant beds, lawns, and erosion control grass areas for the presence of weeds. If weeds are present manually remove.

3.06 SOIL PREPARATION AND FINISH GRADING

A. Remove debris, sticks, roots, clods, stones, and soils contaminated by petroleum products at plant beds and lawns. Rake smooth, eliminate uneven areas or low spots in Soil Material, and set grades for positive drainage.

B. At plant beds:
1. Manually remove weeds as described in Initial Weed Control.
2. Spread 3 inches Organic Material over entire plant bed. Organic Material must be incorporated immediately into plant beds, no stock piling is permitted.
3. Notify Owner's Representativet for Organic Material Placement Review prior to proceeding with tilling and planting.
4. Thoroughly rototill Organic Material into the top 6 inches of Soil Material, except within 10 feet of existing trees and Tree Protection zones where plants will be pocket planted.
5. Rake smooth and reset finish grades eliminating uneven or low spots in plant beds and setting grades for positive drainage. Ensure grades at edges of plant beds allow for placement of Mulch Material to specified depths and as detailed.

C. At trees:
1. Thoroughly mix 5 parts Soil Material and 1 part Organic Material for backfilling trees.

D. At lawns and eco lawns:
1. Manually remove weeds as described in Initial Weed Control.
2. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.
3. Rototill to a minimum depth of 4 inches, except within 10 feet of existing trees and Tree Protection zones.
4. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
5. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
6. Firm seed bed with a lawn roller making passes in 2 directions.

E. At reinforced lawn at fire lane:
1. Manually remove weeds as described in Initial Weed Control.
2. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
3. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.
4. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.

F. At lawn repair areas:
1. Manually remove weeds as described in Initial Weed Control.
2. Place additional Soil Material as necessary to fill in depressions and blend grades with surrounding lawns, plant beds, and paving.

3. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
4. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
5. Firm seed bed with a lawn roller making passes in 2 directions.
6. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.

G. At renovated lawns in Tree Protection Zones:
1. Strip existing sod and remove from site.
2. Manually remove weeds as described in Initial Weed Control.
3. Core aerate with a minimum of 3 passes.
4. Place additional Soil Material as necessary to fill in depressions and blend grades with surrounding lawns, plant beds, and paving.
5. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
6. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
7. Firm seed bed with a lawn roller making passes in 2 directions.
8. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.

H. Notify Landscape Architect for Finish Grading Review prior to proceeding with Work.

3.07 ACCENT STONE PLACEMENT

A. Install Accent stones where shown on Plans. Make minor adjustments to accomodate irrigation, planting, and other site elements.

B. Notify Landscape Architect at least 2 days prior to commencement of Accent Stone Placement.

C. Accent stone mock-up and stone layout review:
1. Landscape Architect will provide on-site aesthetic direction for stone placement to establish design intent. Acceptable mock-up represents expected quality level of the remaining stone installation and may remain as part of Work.
2. Stake locations of Stones, using irrigation flags of contrasting colors for each stone size.

D. Install Accent Stones in the following sequence:
1. Medium
2. Small

E. Nest Accent Stones into Soil Material or Concrete as detailed. In general, stones should be installed based on the following, in order of importance:
1. Horizontal rather than vertical
2. Wider at the ground than at the top so the stone appears to grow out of the soil.
3. Flatter surface on top, positioned for seating opportunity.

F. Notify Landscape Architect for Accent Stone Placement Review.

3.08 SECOND WEED CONTROL

A. After completion of Soil Preparation and finish grading commence irrigation of all plant beds, lawns, and erosion control grass areas. If weeds are present manually remove.

3.09 INSTALLATION OF PLANT MATERIAL

A. Plant Material Review: Notify Landscape Architect prior to the delivery of all trees and plant materials to the site but prior to installing plants. Landscape Architect will review quality of plant materials and reject plant materials not in compliance the the Plant List and Specifications. This

review is preliminary. Final approval of plants materials will not be given until Completion Review.

B. Plant Material Layout Review: Layout plant material (in containers or B&B) at plant beds for review prior to installation. Notify Landscape Architect for review of plant material layout prior to commencement of planting. The plant material layout review may occur concurrently with the planting mock-up review. Adjust plant materials as directed.

C. Planting Mock-Up Review: Notify Landscape Architect prior to commencement of planting. Install an initial 500 square feet sample of typical plantings for review. Adjust planting procedure as directed.

D. Tree Planting:
   1. Soak container grown, B&B, and BR plants before planting.
   2. Remove extra soil on top of root ball to expose flare of first buttress root. Root flare must be visible at top of root ball.
   3. Dig individual planting holes circular with vertical sides as shown on Planting Detail.
   4. Save and thoroughly loosen soil removed from planting hole and use as backfill around tree. Backfill trees with specified mixture if additional Soil Material is needed.
   5. Sprinkle micorrhizal fungi to surface of planting holes at rate of 2-4 ounces per inch of stem caliper.
   6. Lift trees by wire basket only. Do not lift trees by trunk or use trunk as a lever to position or move tree.
   7. Set B&B trees in the hole with the north marker facing north unless otherwise approved.
   8. Set root crown as shown on Planting Detail not less than 3 inches above surrounding finish grade.
   9. Cut and completely remove twine and other fasteners from root ball. Remove burlap from top half of root ball. Remove all burlap if not biodegradable. Neatly cut off broken or frayed roots.
   10. Remove top half of wire basket after planting.
   11. Stake trees as shown on Planting Detail.

E. All other Plants:
   1. Soak container grown, B&B, and BR plants before planting.
   2. Dig individual planting holes with circular and with vertical sides 1-1/2 inch shallower than depth of root ball.
   3. Dig holes for pocket-planted shrubs 3 times the diameter of the rootball.
   4. Sprinkle micorrhizal fungi to surface of planting holes at the following rates:
      a. #SP4 container - 1 tablespoon
      b. #1 container - 2 tablespoons
      c. #3 container - 3 tablespoons
      d. #5 container - 5 tablespoons
   5. Install Planting Tablet at shrubs and ground covers at manufacturer's recommended high rate.
   6. Cut circling roots with a sharp knife.
   7. Set root crowns 1-1/2 inch above surrounding grade and as detailed.

F. Plants set too deeply will be rejected. Reset plants that have settled.

G. Set Plants plumb and for best appearance.

H. Carefully tamp soil under and around root balls and bare roots to prevent settlement.

I. Backfill pocket-planted plants with equal parts Soil Material and Organic Material.

J. Flood hole when half backfilled and tamp soil between bare roots.

K. Complete backfilling and tamp soil between bare roots.

L. Thoroughly water each plant and entire bed immediately after planting.

M. Remove all tags, labels, strings, etc. from plants.

N. Prune Plant Material to remove dead, broken, or damaged branches.

O. Rake plant beds smooth, resetting finish grades for positive drainage and eliminating uneven or low spots.

P. Bulb Planting:

1. Dig individual holes to the depth, size, and spacing scheduled on the Plant List.
2. Place one teaspoon of Installation Fertilizer and work into soil. Place bulb and backfill soil.
3. Cover entire area shown on Drawing as Mulch Area with Perennial Bulbs with 3 inches Organic Material as a mulch.

3.10 MULCH INSTALLATION

A. Install mulch within 24 hours after planting at plant beds and trees as shown on drawings and details at the following depths:

1. Hemlock Bark: 3 inches
2. River Rock/Stone Mulch: 3 inches.

B. Remove excess Mulch from foliage of plant materials and from bark of trees. Mulch must not be placed within 3 inches of tree trunks. Remove mulch from adjacent surfaces and produce edges shown on Details.

3.11 LAWN AND ECO LAWN INSTALLATION

A. Install lawns and eco lawns using one of the following methods

1. Hand seeding:
   a. Apply seed evenly at rate of 6 lbs at lawns per 1000 square feet and 16 lbs per acre at eco lawn, meadow, and wet prairie.
   b. Apply Lawn Installation Fertilizer at a rate of 15 lbs per 1000 square feet.
   c. Rake lightly to a depth of 1/16 inch.
   d. Roll seeded area with half full lawn roller.
   e. Apply approved mulch as necessary to keep areas moist during germination.
2. Terraseeding:
   a. Apply a 1 inch layer of Top Dressing injected with the following:
      1) Seed: 8 lbs per 1000 square feet at lawns or per manufacturer's specifications and 16 lbs per acre at eco lawn.
      2) Lawn Installation Fertilizer: 15 lbs per 1000 square feet.
   b. Do not install Top Dressing within mulch circles at trees.
   c. Approved Installer: Rexius Forest Byproducts, Eugene, Oregon, or approved.

B. Apply water with fine spray immediately after each area is sown.

3.12 TREE PRUNING

A. Perform pruning of trees as recommended in ANSI A300.

B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.13 MAINTENANCE

A. At Plant Beds during period between installation and Final Completion:

1. Water, fertilize, weed, reset unstable or disturbed plants, and perform other maintenance necessary to assure healthy growth.
2. Install Plant Bed Maintenance Fertilizer at a rate of 6 lbs per 1000 square feet 45-60 days after installation. Adjust timing for seasonal requirements of plant materials.
3. Thoroughly water immediately after applying Plant Bed Maintenance Fertilizer.
4. Repair and regrade erosion damage .

5. Provide continued weed control and removal until any weed problem is fully eradicated.

B. At lawns during period between installation and Final Completion:
   1. Water, weed, mow, reseed, top dress, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass; maintain at 2 inches high. This includes unirrigated lawns, unless otherwise noted on drawings.
   2. Conduct first mowing after grass is firmly rooted and secure. Mow grass when it exceeds 2 inches in height, cutting no more than 1/3 of the grass height at a time. Remove all clippings.
   3. Maintain surfaces and supply additional Soil Material and Seed where necessary.
   4. After first mowing apply Lawn Maintenance Fertilizer at a rate of 8 lbs per 1000 square feet. Thoroughly water after application.
   5. Manually remove weeds.

C. At eco lawn between installation and final completion:
   1. Water, weed, mow, reseed, top dress, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass.
   2. Maintain surfaces and supply additional Soil Material and Seed where necessary.
   3. Manually remove weeds.

3.14 CLEANING

A. Remove excess materials from site. Protect drain inlets and underground piping as necessary and clean improvements soiled by Work of this Section.

3.15 COMPLETION REVIEW

A. Notify Landscape Architect for Completion Review when Work of this Section is complete.

END OF SECTION

WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service, fire-service mains, and combined water service and fire-service mains.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Valves and accessories
   2. Water meters and accessories
   3. Backflow preventers and assemblies.
   4. Fire hydrants.
   5. Fire department connections.
   6. Pipe.

B. Field quality-control test reports.

C. Operation and maintenance data for the following:
   1. Water meters
   2. Valves
   3. Backflow preventers
   4. Hydrants

D. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of EWEB. 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.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG'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.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of water-distribution service without Architect's written permission.

1.5 COORDINATION

A. Coordinate connection to water main with EWEB.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L, water tube, annealed temper.
   1. Copper, Solder-Joint 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 and ASTM B 88, Type L, water tube, drawn temper.
   1. Copper, Solder-Joint 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. 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.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. 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.
   2. Gaskets: AWWA C111, rubber.

E. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150 and Class 200.
   1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

F. PVC Schedule 40 Pipe: STM D 1785.
   1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.

G. 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.

H. PVC, AWWA Pipe: AWWA C900, Class 150 and Class 200, with bell end with gasket, and with spigot end.
   1. Comply with UL 1285 for fire-service mains if indicated.
   2. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Gaskets: AWWA C111, rubber.

2.2 JOINING MATERIALS

A. Refer to Section 33 05 00 "Common Work Results for Utilities" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

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

D. Soldering Flux: ASTM B 813, water-flushable type.

E. Solder Filler Metal: ASTM B 32, lead-free type with .20 percent maximum lead content.

2.3 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:
   1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
      a. Standard: AWWA C219.

2.4 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:
   1. 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:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings, or a comparable product by one of the following:
      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. East Jordan Iron Works, Inc.
      f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      g. McWane, Inc.; Kennedy Valve Div.
      h. McWane, Inc.; M & H Valve Company Div.
      i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
      j. Mueller Co.; Water Products Div.
      k. NIBCO INC.
      l. U.S. Pipe and Foundry Company.
   3. Nonrising-Stem, Resilient-Seated Gate Valves:
      a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
         1) Standard: AWWA C509.
         2) Minimum Pressure Rating: 200 psig.
         3) End Connections: Mechanical joint.
         4) Interior Coating: Complying with AWWA C550.
   4. Nonrising-Stem, Resilient Wedge Gate Valve:
      a. Description: ductile iron body bonnet and wedge. The wedge shall be encapsulated in rubber.
         1) Standard: AWWA C515.
         2) Minimum pressure rating: 200 psig.
         3) End Connections: Mechanical joint.
         4) Interior coating: Complying with AWWA C550.
   5. OS&Y, Rising Stem, Resilient-Seated Gate Valves.
      a. Description: Ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
         1) Standard: AWWA C515.
         2) Minimum Pressure Rating: 200 psig.
         3) End Connections: Mechanical joint.

4) Interior Coating: Complying with AWWA C550.

6. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
   a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
      1) Standard: AWWA C509.
      2) Minimum Pressure Rating: 200 psig.
      3) End Connections: Flanged.

B. UL/FMG, Cast-Iron Gate Valves:
   1. 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:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. American Cast Iron Pipe Co.; American Flow Control Div.
      b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
      c. Crane Co.; Crane Valve Group; Stockham Div.
      d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).McWane, Inc.; Kennedy Valve Div.
      e. McWane, Inc.; M & H Valve Company Div.
      f. Mueller Co.; Water Products Div.
      g. NIBCO INC.
      h. U.S. Pipe and Foundry Company.
   3. UL/FMG, Nonrising-Stem Gate Valves:
      a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
         1) Standards: UL 262 and FMG approved.
         2) Minimum Pressure Rating: 175 psig.
         3) End Connections: Flanged.
   4. OS&Y, Rising-Stem Gate Valves:
      a. Description: Iron body and bonnet and bronze seating material.
         1) Standards: UL 262 and FMG approved.
         2) Minimum Pressure Rating: 175 psig.
         3) End Connections: Flanged.

C. Bronze Gate Valves:
   1. 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:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      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. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Red-White Valve Corporation.
   3. OS&Y, Rising-Stem Gate Valves:
      a. Description: Bronze body and bonnet and bronze stem.
         1) Standards: UL 262 and FMG approved.
         2) Minimum Pressure Rating: 175 psig.
         3) End Connections: Threaded.
   4. Nonrising-Stem Gate Valves:
      a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
         1) Standard: MSS SP-80.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:
   1. 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:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
      b. East Jordan Iron Works, Inc.
      c. Flowserve.
      d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      e. McWane, Inc.; Kennedy Valve Div.
      f. McWane, Inc.; M & H Valve Company Div.
      g. Mueller Co.; Water Products Div.
      h. U.S. Pipe and Foundry Company.
   3. Description: Sleeve and valve compatible with drilling machine.
      a. Standard: MSS SP-60.
      b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, 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.
      c. 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," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.6 CORPORATION VALVES AND CURB VALVES

A. Manufacturers:
   1. 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:
      a. Amcast Industrial Corporation; Lee Brass Co.
      b. Ford Meter Box Company, Inc. (The); Pipe Products Div.
      c. Jones, James Company.
      d. Master Meter, Inc.
      e. McDonald, A. Y. Mfg. Co.
      f. Mueller Co.; Water Products Div.
      g. Red Hed Manufacturing & Supply.

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," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
   1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.7 WATER METERS

A. Water meters will be furnished by utility company.

2.8 BACKFLOW PREVENTERS

1. Reduced-Pressure-Principle Backflow Preventers:
2. 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:
   a. Ames Fire & Waterworks; a division of Watts Regulator Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Water Technologies, Inc.
   f. Wilkins; a Zurn company.
3. Standard: AWWA C511.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
6. Size: 3”
7. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved; steel with interior lining complying with AWWA C550 or that is FDA approved; or stainless steel for NPS 2-1/2 and larger.
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
9. Configuration: Designed for horizontal, straight through flow.
10. Accessories:
    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Double-Check Detector, Backflow-Prevention Assemblies:
   1. 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:
      a. Ames Fire & Waterworks; a division of Watts Regulator Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      d. Flomatic Corporation.
      e. Watts Water Technologies, Inc.
      f. Wilkins; a Zurn company.
   2. Standard: AWWA C510.
   3. Operation: Continuous-pressure applications, unless otherwise indicated.
   4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
   5. Size: Insert NPS.
   6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, steel with interior lining complying with AWWA C550 or that is FDA approved, or stainless steel for NPS 2-1/2 and larger.
   7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   8. By-pass meter reading: gallons/min.
   9. Configuration: Designed for horizontal, straight through flow.
   10. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.9 WATER METER BOXES

A. Water meter boxes will be furnished by EWEB.

2.10 CONCRETE VAULTS

A. Description: Precast, reinforced-concrete vault, designed for H-20 load designation according to ASTM C 857 and made according to ASTM C 858. Contractor to size vault based on required clearances and backflow preventers selected.
   1. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
   2. Hatch: 30” diamond plate aluminum or galvanized steel door.
   3. Drain: Sump pump daylighting to closest curb per EWEB requirements.
   4. Riser extensions: Provide riser extensions matching vault size as necessary to match proposed grades.

2.11 ABOVE-GROUND BACKFLOW ENCLOSURE

A. Sized to be smallest possible product based on required clearances and backflow preventer selected.
   1. 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:
      a. Hotbox
      b. Strongbox
   2. Insulated or heated to meet EWEB requirements.
   3. Approval of color and type by architect and landscape architect prior to purchase required.

2.12 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:
   1. 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:
      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. East Jordan Iron Works, Inc.
      f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      g. McWane, Inc.; Kennedy Valve Div.
      h. McWane, Inc.; M & H Valve Company Div.
      i. Mueller Co.; Water Products Div.
      j. Troy Valve; a division of Penn-Troy Manufacturing, Inc.
      k. U.S. Pipe and Foundry Company.
   2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 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.
      a. Standard: AWWA C502.
      b. Pressure Rating: 150 psig minimum.
      c. Outlet Threads: external hose thread used by local fire department. Include cast-iron caps with steel chains.
      d. Exterior Finish: In conformance with local requirements.

2.13 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

1. 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:
   a. Elkhart Brass Mfg. Co., Inc.
   b. Fire End & Croker Corporation.
   c. Guardian Fire Equipment, Inc.
   d. Kidde Fire Fighting.
   e. Potter Roemer.
   f. Reliable Automatic Sprinkler Co., Inc.
2. Description: Exposed, Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.
   a. Standard: UL 405.
   b. Connections: Two NPS 2-1/2 inlets and one NPS 4 outlet.
   c. Inlet Alignment: Inline, horizontal.
   d. Finish Including Sleeve: Rough chrome-plated.
   e. Escutcheon Plate Marking: "AUTO SPKR & STANDPIPE."
   f. Exterior Finish: Red or orange OSHA safety colors.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 31 20 00 "Earth Moving" 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, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 3 shall be:
   1. Soft copper tube, ASTM B 88, Type K or ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
   2. PVC, Schedule 40 or Schedule 80 socket fitting; and solvent-cemented joints.

F. Underground water-service piping NPS 4 and NPS 12 shall be any of the following:
   1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
   2. NPS 4 to NPS 12: PVC, AWWA C900 Class 150 pipe; PVC, AWWA Class 150 ductile iron, mechanical-joint fittings; and gasketed joints.

G. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 shall be same as underground water-service piping.

H. Aboveground and Vault Water-Service Piping NPS 3/4 to NPS 3 shall be hard copper tube, ASTM B 88, Type K or ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

I. Aboveground and vault water-service piping NPS 4 and NPS 6 shall be any of the following:
   1. Hard copper tube, ASTM B 88, Type K, or ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

2. Ductile-iron, flanged-end pipe; ductile-iron, flanged-end appurtenances; and flanged joints.

J. Aboveground and vault water-service piping NPS 8 shall be any of the following:
1. Ductile-iron, flanged-end pipe; ductile-iron, flanged-end appurtenances; and flanges joints.

K. Underground Fire-Service-Main Piping NPS 4 to NPS 8 shall be any of the following:
1. Ductile-iron, push-on-joint pipe; ductile-iron, mechanical-joint fittings; and gasketed joints.
2. PE, Class 150 or 200, fire-service pipe; molded PE fittings; and heat-fusion joints.
3. PVC, AWWA Class 150 pipe listed for fire-protection service; ductile iron fittings; and gasketed joints.
4. PVC, AWWA Class 200 pipe listed for fire-protection service; ductile iron fittings; and gasketed joints.

L. Aboveground and Vault Fire-Service-Main Piping NPS 4 to NPS 8 shall be ductile-iron, flanged-end pipe; ductile-iron-pipe appurtenances; and flanged joints.

M. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 10 shall be any of the following:
1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical, ductile-iron-pipe appurtenances joints.
2. PVC, AWWA Class 150 or 200 pipe listed for fire-protection service ductile iron fittings of same class as pipe; and gasketed joints.

N. Aboveground and Vault Combined Water Service and Fire-Service-Main Piping NPS 6 to NPS 10 shall be ductile-iron, flanged-end pipe; ductile-iron-pipe appurtenances; and flanged joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 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 and Larger: AWWA, cast-iron, nonrising-stem, resilient - seated gate valves with valve box.
2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
3. Use the following for valves in vaults and aboveground:
   a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising stem.
   b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated or UL/FMG, cast iron, OS&Y rising stem.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Arrange with EWEB for tap of size and in location indicated in water main.

B. Make connections larger than NPS 2 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 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.
1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

F. Install PE pipe according to ASTM D 2774 and ASTM F 645.

G. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

H. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches below level of maximum frost penetration.

I. 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 within 5 feet of 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.

J. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, mechanical restraints, and other supports.

3.5 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. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
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.

3.6 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. 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.

C. 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. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

C. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.8 WATER METER INSTALLATION

A. Water meter to be installed by EWEB.

3.9 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick, concrete piers, or pipe supports.

3.10 WATER METER BOX INSTALLATION

A. Water meter box to be installed by EWEB.

3.11 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891 and manufacturer's recommendations. Provide sump pump that daylights to curb, power for sump pump, and high water alarm to vault.

3.12 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. AWWA Fire Hydrants: Comply with AWWA M17.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install protective pipe bollards on two sides of each fire department connection if it is within 5' of a vehicular way.

3.14 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water-distribution piping to utility water main or existing water main. Use tapping sleeve and tapping valve or service clamp and corporation valve.

C. Connect water-distribution piping to interior domestic water and fire-suppression piping.

D. Connect waste piping from concrete vault drains to sanitary sewerage system. See Section 33 31 11 "Sanitary Utility Sewerage Piping" for connection to sanitary-sewer or storm-drainage

system. See Section 33 41 00 "Storm Utility Drainage Piping" for connection to storm-sewer piping.

3.15 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete 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: Test at not less than one-and-one-half times working pressure for two hours.
   1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts 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.

3.16 CLEANING

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 do as follows:
      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

SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: gravity-flow, nonpressure and force-main, pressure sanitary sewerage outside the building, with the following components:
   1. Pipe and fittings.
   2. Nonpressure and pressure couplings.
   3. Cleanouts.
   4. Manholes.
   5. Backwater valves.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Backwater valves
   2. Cleanouts
   3. Pipe material.
   4. Mechanical plugs.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Field quality-control reports.

1.4 PROJECT CONDITIONS

A. Site information: Research public utility records and verify existing utility locations prior to ordering any materials. Notify the Architect immediately if any discrepancies are found in the project survey.

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. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 “Piping Applications” Article for applications of pipe, fitting, and joining materials.

2.3 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C11, rubber.

2.4 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:
1. Pipe: ASTM F 949, T-1 wall thickness, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Type PSM Sewer Piping:
1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for solvent-cemented or gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

C. PVC Sewer Piping:
1. Pipe: ASTM F679, T-1 or T-2 wall thickness, PVC gravity sewer pipe with bell and spigot ends with integral ASTM F477, elastomeric seals for gasketed joints.

D. PVC Service Pipe and Fittings: ASTM E 1785 Schedule 40 or 80 pipe, with plain ends for solvent-cement joints with ASTM D 2466, Schedule 40 or ASTM D 2467, Schedule 80 socket-type fittings.

2.5 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.6 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:
1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:
1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:
1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.7 CLEANOUTS

A. Cleanouts: At grade cleanouts shall have an adjustable sleeve-type housing, a threaded brass plug with counter sunk slot, and cast iron frame and cover.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fittings and riser to cleanout.

2.8 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints rubber gasketed joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation if site conditions warrant and/or as shown in plans.
   4. Base Section: 6-inch minimum thickness for floor slab and 5 inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
   5. Riser Sections: 5-inch minimum thickness, of length to provide depth indicated.
   6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
   7. Gaskets: ASTM C 443 (ASTM C443M), rubber or preformed plastic.
   8. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
   9. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
   10. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
   11. Adjusting Rings: Interlocking rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
   12. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
   1. Description: Ferrous; 23-inch ID by 3- to 7-inch riser, with 3 ¼ -inch- minimum-width flange and 24 ¾-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
   2. Material: ASTM A 536, Grade 60-40-18 ductile or ASTM A 48/A 48M, Class 35 gray iron designed for heavy duty service unless otherwise indicated.

2.9 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, 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: 3000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3000 psi 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: Uniform slope through manhole to match invert elevations per plans, minimum 2 percent.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.10 BACKWATER VALVES

A. Gray-Iron Backwater Valves: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
   1. Available Manufacturers:
      a. Josam Co.
      b. McWane, Inc.; Tyler Pipe; Wade Div.
      c. Smith, Jay R. Mfg. Co.
      d. Watts Industries, Inc.; Ancon Drain Div.
      e. Watts Industries, Inc.; Empoco, Inc. Div.
      f. Zurn Industries, Inc.; Hydromechanics Div.
      g. Approved equal.

B. PVC Backwater Valve: PVC Body with extendable riser pipe.
   1. Available Manufacturers:
      a. Clean Check.
      b. Rector Seal.
      c. Mainline.
      d. Approved equal

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
   1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
      a. Unshielded or Shielded flexible couplings for same or minor difference OD pipes.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Gravity-flow, Nonpressure Sewer Piping: Use any of the following pipe materials for each size range.
   1. NPS 18 to NPS 48: PVC corrugated sewer pipe and fittings; gaskets; and gasketed joints.
   2. NPS 4 to NPS 15: PVC sewer pipe and fittings gaskets, and gasketed joints.

3.3 PIPING INSTALLATION

A. Install tracer wire directly over piping and at outside edges of underground structures. See Section 31 20 00 “Earth Moving” for tracer wire material requirements.

B. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

C. 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.

D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

E. Install 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.

F. Install gravity-flow, nonpressure, sewer piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
   2. Install piping with 36-inch minimum cover.
   3. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
   4. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

H. 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.

I. Install backwater valves in piping where indicated.

3.4 PIPE JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Section 33 05 00 “Common Work Results for Utilities.” Where specific joint construction is not indicated, follow piping manufacturer’s written instructions.

B. Join gravity-flow, nonpressure, drainage piping according to the following:
   1. Join PVC corrugated sewer piping according to ASTM D 2321.
   2. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
   3. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.
   4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.

C. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      a. Unshielded flexible couplings for pipes of same or slightly different OD.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.5 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface for manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.7 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use pipe fittings in sewer pipes at branches for cleanouts, and use PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot- areas.
   2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, per the Detail. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.8 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drain. Use transition fitting to join dissimilar piping materials.

B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.
   1. 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 overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by core drilling into existing unit. Make connection into existing pipe using an “Inserta-Tee” fitting per the manufacturer’s recommendations or approved equal. Make connection to existing manhole using round rubber gasket installed on the pipe per the manufacturer’s instructions. Cut end of connection pipe passing through the manhole wall to conform to the shape of and be flush with the inside wall unless otherwise indicated. The opening around the gasket shall be grouted to a watertight seal. Existing manhole inverts, flow lines, channels, etc. shall be chipped out and re-grouted to accommodate the new pipe.
      a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
      b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to grease, oil, and sand interceptors.

E. Make connections to existing piping and underground structures so finished Work complies with requirements specified for new Work.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. 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. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. 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 requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
      b. Allowable leakage is maximum of 50 gal. /inch of nominal pipe size per mile of pipe, during 24-hour period.
      c. Close openings in system and fill with water.
      d. Purge air and refill with water.
      e. Disconnect water supply.
      f. Test and inspect joints for leaks.
      g. Option: Test concrete gravity sewer piping according to ASTM C 924.
   6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION

STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes gravity-flow nonpressure storm drainage outside the building, with the following components:
   1. Pipe and fittings.
   2. Trench Drains.
   3. Manholes.
   4. Cleanouts.
   5. Nonpressure transition couplings.
   6. Catch basins.
   7. Stormwater inlets.
   8. Overflow inlets.
   9. Water quality manhole.
   10. Pipe outlets.
   11. Rainwater harvesting cistern.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Backwater valves.
   2. Cleanouts.
   3. Inlets.
   4. Pipe.
   5. Fittings.
   6. Drains.
   7. Trench Drains.
   8. Cistern.

B. Shop Drawings:
   1. Precast Concrete Manholes & Water Quality Manholes: Include plans, elevations, sections, details, frames, and covers.
   2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.
   3. Rainwater harvesting cistern.
   4. Cast-in-place concrete manholes, including frames and covers.
   5. Pre-cast concrete structures, including frames and covers.

C. Field quality-control reports.

1.3 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Architect's written permission.

B. Site Information: Research public utility records, and verify existing utility locations prior to ordering any materials. Notify Architect immediately if any discrepancies are found in the project Survey.

PART 2 - PRODUCTS

2.1 Refer to Part 3 "Piping Applications" for applications of pipe, fitting, and joining materials.

2.2 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.3 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.4 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:
   1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
   3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35 with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

C. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T- 1 or 2 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.5 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Concrete Pipes: ASTM C 443, rubber.
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
   1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
   1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:
   1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts:
   1. Description: Cleanouts: At grade cleanouts shall have an adjustable sleeve-type housing, a threaded brass plug with counter sunk slot, and cast iron frame and cover.
   2. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty, and Extra-Heavy Duty.
   3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:
   1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.7 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation, if site conditions warrant and/or as shown in the plans.
   4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
   6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
   7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
   8. Steps: Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
   9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
   10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
   1. Description: Ferrous; 23-inch ID by 6- to 10-inch riser with 3.5-inch- minimum width flange and 25-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
   2. Material: ASTM A 536, Grade 60-40-18 ductile or ASTM A 48/A 48M, Class 30 gray iron unless otherwise indicated.

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, 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. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3000 psi 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: 1 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
   a. Slope: 4 percent.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.9 POLYMER-CONCRETE TRENCH DRAINS

A. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ACO USA.
2. Poly-Cast.
3. Zurn.
4. Approved equal.

C. Polymer-Concrete Systems:
1. Channel Sections:
   a. Interlocking-joint, precast, modular units with end caps.
   b. 4-inch inside width and deep, rounded bottom, and with outlets in quantities, sizes, and locations indicated.
   c. Extension sections necessary for required depth.
   d. Frame: Include ductile iron or steel frame for grate.
2. Grates:
   a. Decorative grate type Jamison by Urban Accessories where shown on plans.
   b. Standard grates to be manufacturer's designation "Heavy Duty," with slots or perforations that fit recesses in channels where shown on plans.
      1) Material: Galvanized steel, Ductile iron, or Stainless steel per the plans.
3. Covers: Solid gray iron if indicated.
4. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
5. Invert: Per Plan.

D. Drainage Specialties: Precast, polymer-concrete units.
1. In-line Catch Basins:
   a. 24-inch deep polymer-concrete body, with outlets in quantities and sizes indicated.
   b. ADA iron.
   c. Grate load class: C.

E. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

F. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.10 CATCH BASINS

A. Trapped Catch Basins:
1. 1/4-inch or 10-gage steel plate bituminous coated as manufactured by Lynch, Gratemaster, Gibson Steel Basins, or approved equivalent. Reinforced concrete collars shall be installed per the Drawings.
2. Nyloplast Drain Basin with EnviroHood, or approved equivalent. Reinforced concrete collars shall be installed per the drawings.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for heavy-duty service H-20, structural loading. Include flat grate with small square or short-slotted drainage openings.
   1. Size: To match basin, 28 by 28 inches minimum unless otherwise indicated.
   2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.11 WATER QUALITY MANHOLE

A. Contech CDS model CDS2015-F-C

2.12 RAINWATER HARVESTING CISTERN

A. Xerxes 10’ diameter single-wall water and wastewater tank with a 15,000 gallon capacity and prefabricated engineered concrete deadmen.
   1. Provide Xerxes fittings, including risers, openings, piping penetrations, sumps as shown on Drawings.

2.13 PIPE OUTLETS

A. Concrete Pipe Outfall: as shown on Plans.

2.14 OVERFLOW INLETS

A. Ditch Inlets: Made with face opening to match side slopes of materials and dimensions as shown on the Drawings.

B. Overflow Inlets: Round inlet by Gibson Steel Basins or approved equivalent with a ductile iron beehive grate. All materials and dimensions as shown on the Drawings.

PART 3 - EXECUTION

3.1 EARTHWORK

1. Excavation, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving." Install tracer wire directly over piping and at outside edges of underground structures. See section 31 20 00 “Earth Moving” for tracer wire material requirements.

3.2 PIPING INSTALLATION

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 into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

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.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process or microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow at a minimum slope of 1 percent, unless otherwise indicated.
   2. Install piping with 36-inch minimum cover, unless otherwise indicated.
   3. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
   4. Install PE corrugated sewer piping according to ASTM D 2321.

5. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
6. Install piping below frost line.

G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
1. Ductile-iron pipe and fittings.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.3 PIPE JOINT CONSTRUCTION

A. Basic pipe joint construction is specified in Division 33 Section “Common Work Results for Utilities.” Where specific joint construction is not indicted, follow piping manufacturer’s written instructions.

B. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
2. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
3. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
4. Join PVC corrugated sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints.
5. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
6. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
7. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC fittings in sewer pipes at branches for cleanouts and PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, as indicated on plans. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.7 RAINWATER HARVESTING CISTERN INSTALLTION

A. Per the manufacturer’s recommendations.

3.8 WATER QUALITY MANHOLE INSTALLATION

A. Per the manufacturer's recommendations.

3.9 STORMWATER OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap as indicated.

3.10 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.11 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 22 14 13 "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.
   1. 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 overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches 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, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
      a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
      b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Pipe couplings and expansion joints with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      a. Unshielded or Shielded flexible couplings for same or minor difference OD pipes.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.12 IDENTIFICATION

A. Install green tracer wire directly over piping and at outside edges of underground structure. See Section 31 20 00 "Earth Moving" for tracer wire material requirements.

3.13 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. 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. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. 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 requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      a. Option: Test plastic piping according to ASTM F 1417.
      b. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes subdrainage systems for retaining walls, foundations, footings, and stormwater infiltration facilities:

1. Perforated-wall pipe and fittings.
2. Geotextile filter fabrics.
3. Backwater valves.

1.2 SUBMITTALS

A. Product Data:

1. For geotextile filter fabrics.
2. Perforated pipe.
3. Solid-wall pipe.

B. Inspection report.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated schedule 40 PVC Sewer Pipe and Fittings: ASTM D 1785, D2665 or F891, solvent welded joints.

2.2 SOLID-WALL PIPES AND FITTINGS

A. Refer to specification section 33 41 00 “Storm Utility Drainage Piping.”

2.3 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of the same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.

B. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.5 SOIL MATERIALS

A. Backfill, drainage course, and satisfactory soil materials are specified in Division 31 Section 31 20 00 "Earth Moving."

2.6 GEOTEXTILE FILTER FABRICS

A. Use “Drainage Fabric” as found in 31 20 00 “Earth Moving.”

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Style(s): Flat and sock.

2.7 BACKWATER VALVES

A. PVC Backwater Valve: PVC Body with extendable riser pipe.

1. Available Manufacturers:

a. Clean Check.
b. Rector Seal.
c. Mainline.
d. Approved equal

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section 31 20 00 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Underground Perimeter Foundation and Wall Piping:

1. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Header Piping:

1. PVC sewer pipe and fittings, couplings and coupled joints.

C. Stormwater Facility:

1. Perforated PVC Sewer Pipe and fittings, and loose, bell-and-spigot joints.

3.3 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:

1. At Grade in Earth: PVC Cleanouts.
2. At Grade in Paved Areas: PVC cleanouts.

3.4 FOUNDATION DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

D. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests. Refer to Part 3 “Field Quality Control.”

E. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

F. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

G. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.5 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Perimeter Foundation Subdrainage: Install piping with a minimum slope of 0.25 percent in the direction of flow and with a minimum cover of 36 inches unless otherwise indicated.
2. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 unless otherwise indicated.
3. Stormwater Facilities: Install Piping level.
4. Lay perforated pipe with perforations down.
5. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PVC piping according to ASTM D 2321.

3.6 PIPE JOINT CONSTRUCTION

A. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

B. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.7 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 33 41 00 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves where indicated.

3.8 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 33 41 00 "Storm Utility Drainage Piping."

B. Cleanouts for Foundation and Retaining-Wall Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, as shown on Drawings. Set top of cleanout flush with grade.
3. In non-vehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, as shown on Drawings. Set top of cleanout 1 inch above grade.

3.9 CONNECTIONS

A. Connect low elevations of subdrainage system to site’s solid-wall-piping storm drainage system.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION

SECTION 33 46 13
SPORTS FIELD SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Subdrainage system and associated trenching at grass play field.

1.02 RELATED REQUIREMENTS
A. Section 01 23 00 - Alternates: Description of Alternates.
B. Section 32 90 00 - Planting.
C. Section 33 40 00 - Storm Utility Drainage Piping.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on pipe drainage products, pipe accessories, and sieve analysis of Sand.
C. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.
D. Quality Assurance Data: Submit description of previous projects including owner name and contact information, addresses, and description of project.

1.04 REVIEWS
A. Owner's Representative review of the subgrade drainage including, but not limited to, pipes, joints, connections is required prior to backfilling. Notify Owner's Representative for review at least 48 hours in advance.

1.05 QUALITY ASSURANCE
A. Contractor qualifications:
   1. Minimum of 3 years documented experience installing subdrainage for projects of similar scope and scale.
   2. Licensed Contractor under Oregon Revised Statutes.
   3. Successfully completed at least 10 projects of similar scope and comparable scale.

PART 2 PRODUCTS

2.01 PIPE MATERIALS
A. SUBGRADE DRAIN PIPE
   1. High density perforated corrugated HDPE pipe for use in athletic field subgrade applications made with a minimum of 50% recycled material.
      a. Size: 2 inch pipe
   2. Connections and Fittings: Polypropylene (PE) 2 inch Insert Fittings: end plugs, couplers, 90 degree elbow, tee's, and cross.
B. COLLECTOR PIPE
   1. Refer to storm pipe utility section.

2.02 LOCATOR WIRE
A. 18 gauge minimum insulated copper wire, green in color.

2.03 DRAINAGE SAND
A. Imported, clean sand to be used for pipe base material, pipe zone material, and trench backfill.

1. Approved Products: Top Dress Sand by Fazio Brothers Inc., or approved.

B. Substitutions: Refer to Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to starting Work of this section verify existing grades and field conditions agree with drawings. Notify Landscape Architect of deviations. Do not start Work until any unsatisfactory conditions have been corrected.

B. Verify location, elevation, type, and size of new storm drainage system to be joined.

3.02 PROTECTION

A. Maintain bench marks, monuments, and reference points. Replace if disturbed or destroyed.

B. Locate and protect existing utilities.

3.03 GENERAL REQUIREMENTS

A. All equipment is to be turf rated not to exceed ground pressure of 15 psi, loaded.

B. Remove obstructions encountered within the tranch area. Make minor adjustments in trench alingment to avoid major obstructions.

C. Minimum trench width to be 1 inch greater than outside diameter of pipe.

D. Remove excavated material from trench using an elevated conveyance system to ensure removal without turf contact. Place excavated material only within approved areas.

E. Keep trenches dry. Provide and operate pumping equipment necessary to keep excavations free from standing water.

F. Close all open trenches the same working day as when opened.

3.04 SUBGRADE DRAIN PIPE INSTALLATION

A. Trench in one step operation.

B. Install pipe mechanically to ensure pipe installation is above the trench bottom and centered within the trench. Pipe installation and trench backfill is to be a one step operation.

C. Provide minimum of 10 inch cover on pipe.

D. Fill trenches to match existing grade.

E. Notify Owner's Representative for reivew of pipe installation prior to backfilling.

3.05 BACKFILLING

A. Pipe Base: Place required thickness of Sand over full width of trench to ensure uniform bearing surface beneath pipe.

B. Pipe Zone: Place required thickness of Sand over full width of trench.

C. Backfill full width of trench to match adjacent lawn soil level.

D. Compact trench backfill in maximum 24 inch lifts to 90 percent compaction per ASTM D698.

3.06 TOLERANCES

A. Install piping within a maxium variation of 1/4 inch of indicated gradient within a 10 foot run.

3.07 SETTLEMENT

A. Correct any settlement in trench backfill during warranty period due to insufficient compaction.

3.08 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspection and testing.

B. Perform a minimum of one field density test on compacted material for every 100 linear feet.

C. Request inspection prior to back filling over pipe.

3.09 PROTECTION

A. Protect pipe from damage or displacement until backfilling operation begins.

END OF SECTION