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Project Manual

PSU LINCOLN HALL BROADWAY ADDITION

Permit Set

July 30, 2010

Volume 2

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PROJECT MANUAL
PERMIT SET

PSU LINCOLN HALL BROADWAY ADDITION
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1620 SW Park Ave.
Portland, OR 97201

July 30, 2010
Project # 07036

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END OF DOCUMENT

BASIC FIRE SUPPRESSION DESIGN BUILD REQUIREMENTS

PART 1 - GENERAL

1.1 DESIGN-BUILD INSTRUCTIONS

A. This document is issued to give Bidders a basis for preparing a proposal to design and install complete fire sprinkler systems for this project.

B. Alternates to this Document may be offered as a separate proposal.

1.2 DESIGN APPROACH

A. Use this Specification as a guide for design/engineering requirements and workmanship and materials or construction. Utilize design-build concept throughout construction phase of project.

B. Investigate and be apprized of applicable codes, rules, and regulations as enforced by AHJs.

1.3 SUMMARY

A. Refer to Architectural, Structural, Mechanical, Plumbing, Electrical, and existing fire protection record drawings and Civil Drawings for additional information relating to the fire suppression system.

B. Work Included: Extend existing wet sprinkler system to serve new and remodeled areas as outlined in this Specification.

1.4 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 21:

1. AHJ Authority Having Jurisdiction.
2. ANSI American National Standards Institute.
3. ASCE American Society of Civil Engineers.
4. ASME American Society of Mechanical Engineers.
5. ASTM American Society for Testing and Materials.
6. ASSE American Society of Sanitary Engineering.
7. AWWA American Water Works Association.
8. ETL Electric Testing Laboratories.
9. FM FM Global.
10. HVAC Heating, Ventilating and Air Conditioning.
11. ICC-ES International Code Council Evaluation Service.
12. MSS Manufacturers Standardization Society.
13. NEC National Electric Code.
14. NEMA National Electrical Manufacturers Association.
15. NFPA National Fire Protection Association.
16. OFC Oregon Fire Code.
17. OSSC Oregon Structural Specialty Code.
18. OSHA Occupational Safety and Health Administration.
19. UL Underwriters Laboratories Inc.
20. UPC Uniform Plumbing Code.

B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

1.5 ADDITIONAL DEFINITIONS TO DIVISION 01

A. Code: Indicates the Regulatory Requirements as applicable to that reference.

B. AHJ: Indicates reviewing authorities, including the local fire marshal, the Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.6 ADDITIONAL REQUIREMENTS TO DIVISION 01

A. Submit the following for review. Include in operations and maintenance manual.

B. Shop Drawings, Calculations, component manufacturer's data sheets: Submit as one complete standalone package to AHJ, Owner's insurance underwriter, and Engineer. Drawings to show information required by NFPA 13, 14, 24 and 25, including room names and occupancy classifications. Refer to individual Specification Sections for additional requirements for the shop drawings, calculations and specific items required in product data submittal.
   1. Shop Drawings: Provide shop drawings which include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and the like.
      a. Contractor shall submit sprinkler head layout to Architect and Owner's representative for approval prior to submission to AHJ for permit approval.
   2. Calculations: Hydraulic, sway brace, and the like calculations.
   3. Product Data: Submit manufacturer's technical data, installation instructions and dimensioned drawings for products, sprinklers, equipment and devices installed, supplied or provided. Submit at one time in 3-ring binder, tabbed and referenced to match the Contract Documents.
   4. Maintain an updated product submittal package to be included in the final operation and maintenance documentation.
   5. Shop Drawings and hydraulics calculations, sway brace calculations, trapeze hanger calculations, and the like, to be prepare under the direct supervision and control of a professional Engineer competent to do such work and licensed in the state of Oregon. Drawings and calculations to bear the seal and wet signature of the professional Engineer.

C. Operation and Maintenance Documentation: Copies of certificates of code authority acceptance, code-required acceptance tests; test reports, parts lists, maintenance information for equipment, valves, and other special guarantees, certificates of warranties, and the like, specified elsewhere herein or indicated on Drawings. Record Drawings, water supply flow test, calculations, manufacturer's data sheets and operation and maintenance instructions, servicing requirements, test reports and certificates, Contractor's Material and Test Certificates for Aboveground Piping/Underground Piping and NFPA 25.

D. Close-out Documentation: Submit fire suppression code authority certification of inspection.

E. Record Drawings:
   1. Show changes and deviations from the Drawings. Include issued Addendum and change order items.
   2. Make changes to the Drawings in a neat, clean, and legible manner.

F. Guaranty: Guaranty systems against defective equipment, materials and workmanship for a period of 1 year after Owner's acceptance.

1.7 QUALITY ASSURANCE

A. Where Contract Documents are at variance with applicable codes governing work, code and local jurisdiction requirements take precedence. Include cost necessary for code compliance or local jurisdiction compliance in bid price. Machinery and equipment to comply with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements.

B. Qualifications: Company specializing in fire-suppression sprinkler, and fire-suppression standpipe systems of similar type and scope with 3 years experience.

C. Installation of fire suppression systems within limitations imposed by architectural, structural, and electrical requirements. Provide adequate space for manufacturer's recommended maintenance and code-required clearances.

D. Prior to submitting products for review, obtain copies of product listings and approvals to determine that product use and application on this project complies with the intended use stated in products listing or approval and to determine whether products listing or approval requires special inspections per IBC Chapter 17. Notify Architect promptly when such products are intended to be used and that special inspection is required. Coordinate inspections with Architect and other trades.

E. Substitutions:
1. Where materials or equipment are specified by name of manufacturer, such specification to be deemed to be used for purposes of establishing a standard of quality for that particular item. Materials or equipment to conform to Specifications and Drawings. Inclusion of a manufacturer's name as acceptable to provide specific equipment does not indicate that manufacturer's standard catalogued components will perform as required, or that they will fit in allocated physical space for equipment. Verify that equipment which is proposed to be provided will fit in allocated physical space, with required manufacturers and code required clearances.
2. Equipment submitted for substitution to meet Contract Document requirements including quality established by brand specified. Indicate deviations or noncompliances by an attached letter explaining a proposed change. Acceptance of submitted material does not grant deviation from Contract requirements. Additional expense resulting by decision to use substitute materials must be included in bid sum and include costs by other affected crafts.
3. Variations in Equipment: If approved fire suppression equipment of other manufacturer requires modification or additions to other work shown on Drawings, arrange for and pay costs of such changes at no additional cost to Owner.
4. "Or Approved": Where equipment make is listed, followed by phrase "or approved," this requires submittal of proposed make prior to bidding for review and approval by Architect.

F. Material and Equipment: Listed for its intended fire suppression use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, or FM Global Approval Guide, or International Code Council Evaluation Service Report.

1.8 PERMITS, CODES, REGULATIONS AND STANDARDS

A. Requirements: As a minimum requirement, work in accordance with following rules and regulations and applicable laws: Apply edition as enforced by AHJ unless otherwise stated. Comply with state and local amendments.
1. OSHA.
2. Related supplements and standards.
3. Oregon Plumbing Specialty Code.
4. State of Oregon and local jurisdictional requirements.
5. ASCE 7, as adopted by AHJ, Minimum Design Loads for Buildings and Other Structures.
6. OFC, as adopted by AHJ, Oregon Fire Code.
7. OSSC, as adopted by AHJ, Oregon Structural Specialty Code.
8. UL Fire Protection Equipment Directory.
9. UL Online Certifications Directory.
10. FM Global Approval Guide.
11. NFPA 13, as adopted by AHJ, Standard for the Installation of Sprinkler Systems.
12. NFPA 25, Latest Edition, Standard for Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
13. ICC-ES AC193 Mechanical Anchors in Concrete Elements.
14. ICC-ES AC308 Post-Installed Adhesive Anchors in Concrete Elements.

B. Where code requirements are at variance with the Drawings and Specifications, meet code requirements as a minimum requirement, and include costs necessary to meet these in Contract. Machinery and equipment complies with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations. See "Letter of Conformance" this Section.

C. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality or capacity than that required by governing codes, higher quality take precedence.

1.9 PERMITS AND INSPECTIONS

A. Unless otherwise distinctly hereinafter specified, apply and pay for necessary permits, plans check, and inspections required by public AHJ.

B. Refer to General and Supplementary Conditions for payment of water service connection fees.

C. Obtain certificates of inspection from AHJs and deliver to Owner before final acceptance.

D. Where concrete anchors and other products require, in accordance with their listing and approval, special inspections per IBC 1704, 1707 or 1708, arrange and pay for, at no additional expense to Owner, such special inspections.

1.10 SEQUENCING AND SCHEDULING

A. For proper execution of work cooperate with other trades as needed.

B. To avoid installation conflicts, thoroughly examine complete set of Contract Documents. Resolve conflicts with Architect prior to fabrication and installation.

C. Prior to installation of equipment requiring electrical connections, examine manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that electrical characteristics indicated in Contract Documents are consistent with electrical characteristics of actual equipment being installed. When inconsistencies occur request clarification from Architect.

1.11 COMPATIBILITY AND COORDINATION

A. Provide mechanical equipment compatible with and acknowledges and accommodates, requirements of other trades. Resolve without additional cost to Owner those details necessary to assure that mechanical systems properly and completely function together when assembled and achieve required design criteria and performance and conform to requirements of governing codes and regulatory agencies.

B. Coordinate various portions of work as to scheduling, installation procedures, Shop Drawings and final installation of related materials. Promptly notify Owner of defects or imperfections which will affect satisfactory completion of this work.

C. Design Criteria: The documents are based on a bidder design concept. See each Section for requirements.

D. Furnish electrical loads required for entire fire suppression system.

1.12 COORDINATION DOCUMENTS

A. Prior to construction, coordinate installation and location of piping, fire sprinklers, standpipes, fire pumps, controllers and electrical services with architectural and structural requirements, and other trades (including plumbing, HVAC equipment, ductwork, grilles, diffusers, electrical, lights, ceiling suspension, and tile systems), and provide reasonable maintenance access requirements.

1.13 SUBMITTALS

A. Refer to Division 01.

B. Shop Drawings:
   1. Unless otherwise approved, provide Fire Suppression Shop Drawings at one time in a vinyl covered three-ring loose-leaf binder.
   2. Clearly reference each item by page and paragraph to applicable portion of Specifications.
   3. Specifically note specified features and performance data on submittal.
   4. Check Shop Drawings for space requirements and conformance with Specifications and mark corrections and approval on Shop Drawings prior to submittal to Architect.
   5. The Engineer will review the original submittal and one resubmittal for the same product. Additional resubmittals will be reviewed on an hourly rate, payable by the contractor.
   6. Partial submittals or submittals not properly formatted as indicated above are subject to return without review for the contractor to correct.
   7. Clearly reference on the drawings which products will require special inspection per IBC 1704, 1707 or 1708, including, but not limited to concrete anchors, and submit a statement of contractor responsibility per IBC 1705.

1.14 VISITING PREMISES

A. Before preparing design-build documents or submitting bid on work, visit site and become familiar with visible existing conditions. No additional allowance will be granted due to lack of information of visible existing conditions.

B. The submission of a bid will be considered an acknowledgment on part of Bidder of his visitation to site.

1.15 CONSTRUCTION DRAWINGS AND DIAGRAMS

A. Submit Construction Drawings showing complete 1/8-inch scale drawings of fire sprinkler systems. Show each system on separate drawings. Provide drawings reflected on Architectural Reflected Ceiling Plan and other appropriate bases.

B. Prepare final Construction Drawings and submit to Architect for review comments. Coordinate drawings with works of other trades and have adequate detail for complete coordination and installation of systems.

C. Prepare Construction Drawings on latest release of AutoCAD.

1.16 CALCULATIONS

A. Submit following calculations:
   1. Submit hydraulic calculations per NFPA Standards and per Section 21 01 00, Basic Fire Suppression Materials and Methods, and per Section 21 13 00 Fire Suppression Sprinkler Systems for each hydraulically most remote zone.
   2. Calculations for seismic bracing of fire suppression equipment and piping where required by law. Calculations to be signed and sealed by a registered engineer in state of Oregon.

B. See individual Specification Sections for further requirements.

1.17 RECORD DRAWINGS

A. Maintain a weekly updated set of as-constructed documents. At conclusion of building project, transfer these weekly updated documents to a set of reproducible sepias of original design.

1.18 WARRANTY

A. General: Provide written warranty on fire suppression work, agreeing to replace/repair inadequate and defective materials and quality of work, including leakage, breakage, improper assembly and failure to perform as required for a period of one year from date of Owner's acceptance. Include separate product warranties as indicated for specific parts or products in work. Provide warranty signed by both Installer and Contractor.

B. Include manufacturer's standard product warranty, covering fire suppression equipment operation under normal conditions and use, where installed, operated and maintained in accordance with manufacturer's instructions. Provide product warranty period terminating 12 months after substantial completion.

PART 2 - PRODUCTS

2.1 HAZARDOUS MATERIALS

A. Do not use products containing asbestos, lead, arsenic, or other material defined by EPA as hazardous to human or animal life.

2.2 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and sprinklers used for construction are to be new, the latest products as listed in manufacturer's printed catalog data and are to be UL or FM approved or acceptable by state, county, and city authorities. Equipment supplier is responsible for obtaining state, county, and city acceptance on equipment not UL approved or not listed for installation.

B. Materials, sprinklers, and equipment of a kind to be standard product of one manufacturer and of current manufacture.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

PART 3 - EXECUTION

3.1 FIRE SPRINKLER COORDINATION

A. Provide complete fire sprinkler layout to architect and engineer prior to pipe layout and calculations. Proceed with layout and calculations after receiving approval of head layout from architect.

B. Ceiling Areas: Piping shall be concealed except in areas where space is not available, then pipe location shall be coordinated with the Architect. Coordinate sprinkler head locations with lights, speakers, and other ceiling mounted appurtenances and mount heads in ceiling tiles, centered in both directions.

3.2 INSPECTION

A. Work and materials subject to inspection by Architect and/or Owner's Representative.

3.3 SUPERVISION

A. Constantly supervise work covered by these Specifications. Verify conditions on job site and lay out work accordingly.

3.4 EQUIPMENT IDENTIFICATION

A. Each new piece of equipment bears a permanently attached identification plate, listing manufacturer's name, capacities, sizes and characteristics.

3.5 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Prior to acceptance of work and during time designated by Architect, provide necessary qualified personnel to operate system for period of 4 hours.

B. During operating period, fully instruct Owner's Representative in complete operations, adjustment and maintenance of each respective installation.

C. Operations and Maintenance Data: At time of system demonstration, deliver to Owner two bound copies (3-ring binder type) of operation and maintenance manuals containing following materials:
   1. Catalog description of each item of equipment actually installed on job.
   2. Instructions for operation and maintenance of fire suppression systems composed of operating instructions, maintenance instructions and manufacturer's literature as follows:
      a. Maintenance Schedule Chart: Provide an 8-1/2- by 11-inch typewritten list of each item of installed equipment requiring inspection, lubrication or service, describing and scheduling performance of such maintenance.
      b. Manufacturer's Literature: Provide copies of manufacturer's instructions for operation and maintenance of fire suppression equipment, including replacement parts list with name and address of nearest distributor. Mark each copy with equipment identification label as listed in equipment schedule, i.e. F-5, P-10, etc.
      c. NFPA 25.
      d. Hydraulic calculations.
      e. Seismic sway brace calculations.
      f. Location of dry system drains and auxiliary drains, method of complete drainage.
      g. Maintenance of air compressor.

3.6 ACCESSIBILITY AND INSTALLATION

A. Install equipment having components requiring access (i.e., drains, valves, motors, engines, controllers, air compressors, gauges, fill cups, tanks, drives, and the like) so that they may be serviced, reset, replaced or recalibrated and the like, by service people with normal service tools and equipment. Notify Architect in writing if equipment or components are shown in such a position that above cannot be accomplished.

B. Install equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment, examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods and sequencing, in coordination with other trades and disciplines.

C. Firestopping:
   1. Coordinate with Drawings location of fire rated walls, ceilings, floors and the like. When these assemblies are penetrated, seal around piping, equipment, and the like, with approved firestopping material.
   2. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

3.7 NOISE AND VIBRATION

A. Install vibration isolators and measures required to prevent noise and vibration from being transmitted to occupied areas. Select equipment to operate within noise coefficient (NC) design level for particular type of installation in relation to its location.

B. After installation, make proper adjustments to reduce noise and vibration to acceptable levels as defined by Architect.

3.8 SEISMIC CONTROL

A. Provide the following:
   1. General:
      a. Earthquake resistant designs for fire suppression equipment, i.e., standpipes, fire suppression piping, to conform to regulations of OSSC.
      b. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment, piping, and the like, to withstand a force in direction equal to value defined in OSSC.
      c. Retain licensed structural engineer to provide shop drawings of seismic bracing and seismic movement assemblies for piping and the like. Engineer to design and provide stamped shop drawings for equipment, tanks, pumps, piping seismic bracing, and the like. Submit shop drawings along with equipment submittals.
      d. Retain licensed structural engineer to provide shop drawings of seismic flexible joints for piping and the like crossing building expansion or seismic joints. Engineer to design and provide stamped shop drawings for piping flexible seismic joints. Coordinate actual design deflection or travel with project structural engineer. Submit shop drawings along with seismic bracing details. Coordinate exact design requirements from project structural engineer.
      e. Flexible drops for sprinklers in conformance with OSSC and ASCE 7 requirements of ceilings. Coordinate with Architectural and Structural Drawings and Specifications.
   2. Piping:
      a. Use sway brace requirements of OSSC, ASCE 7, and NFPA 13.
      b. As approved by code authority, use a bracing system manufactured by Tolco, Afcon, or approved.
   3. Equipment:
      a. Provide sway bracing to prohibit excessive motion of fire suppression equipment and piping during earthquake.
      b. Provide fire suppression equipment and piping, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight or lateral seismic forces as determined by building code and NFPA 13 calculations, whichever is more demanding.

3.9 REVIEW BY ENGINEER

A. Notify Architect/Engineer, in writing, at following stages of construction so that Architect/Engineer may, at their option, visit site for review and construction observation:
   1. Fire Suppression:
      a. When ceiling installation is started.
      b. When mains or branchlines are to be permanently concealed by construction or insulation systems.
      c. When fire suppression systems, or portions of, are being tested and ready for inspection by AHJ.

B. It is Contractor's responsibility and cost to make piping accessible, expose concealed lines, or demonstrate acceptability of the system. If Contractor fails to notify Architect at times prescribed above, extra cost caused by removal of such work are Contractor costs.

3.10 OPERATING DURING CHANGEOVER

A. During remodeling of existing structure, or addition of a structure to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.

B. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, wiring, and the like, to point of connection.

C. Perform actual transfer to new service at off-peak time, as coordinated with Owner. Once changeover is started, pursue it to its completion, to keep interference to a minimum.

D. During changeover, for the entire time system or part thereof, is not operational, provide a fire watch, including a watchperson whose sole duty is to watch for and report fires.

3.11 MUTILATION

A. Repair mutilation of building around pipes, equipment, hangers, braces, and the like.

3.12 DEMOLITION

A. Coordinate demolition of existing fire suppression systems as depicted on Construction Documents with Contractor. Where applicable or possible, portions of fire suppression demolition work may be performed by Contractor. Verify with local AHJ as to limitations of demolition by others and not fire suppression trades. Coordinate extent of demolition of fire suppression work to be done by others and supervise this work. No extra costs will be approved by replacement of systems due to improper or excessive demolition.

3.13 PIPING AND EQUIPMENT REMOVAL

A. Piping and equipment removed and identified as salvage by Owner to remain property of Owner.

B. Comply with Division 02, Site Demolition.

C. Remove and dispose of excess piping and equipment removed (and not identified by Owner as salvage).

3.14 CUTTING AND PATCHING

A. Cutting and patching performed under Division 23 includes but not be limited to:
   1. Saw cutting and trenching new and existing concrete floors.
   2. Cutting and patching of plaster or partitions.
   3. Cutting and trimming openings in case work for installation or connection of plumbing fixtures. Countertop openings for sinks cut by casework supplier.
   4. Cutting and patching of finished ceilings.

B. Perform cutting and patching by skilled craftsmen in trade of work to be performed. Fill holes which are cut oversized for completed work. Match refinished areas with existing adjacent finish in a manner acceptable to Architect.

C. Verify if existing roof is under warranty. Perform work to maintain warranty.

D. When masonry or concrete construction must be penetrated, furnish and install a steel pipe sleeve in opening and grout in place in a neat manner. Leave grout surface to match existing finish. Provide escutcheons. If sleeves are not provided, core drill penetrations.

E. Locate concealed utilities to eliminate possible service interruption or damage.

F. No extra will be allowed for lack of proper coordination.

3.15 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials and equipment in a manner to prevent damage and deterioration. Store in original container which identifies manufacturer's name, brand and model number. Do not store indoor equipment outdoors unless provided with a waterproof protective cover.

B. Replacement: In event of damage, immediately make necessary repairs and replacements.

3.16 DEMONSTRATION

A. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Representative and Architect that equipment furnished and installed or connected under provisions of these Specifications functions mechanically in manner required.

B. Manufacturer's Field Services: Furnish services of a qualified person for a period of not less than hours, at a time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in a satisfactory manner and complies with requirements of other trades or Contractors that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.17 CLEANING

A. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated by this work.

3.18 INSTALLATION

A. Install equipment and piping in accordance with manufacturer's installation instructions, plumb and level except where required to be pitched. Maintain manufacturer's recommended clearances.

B. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.19 ACCEPTANCE

A. System can not be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
   1. Testing reports including Contractor's Material and Test Certificate for Underground Piping, Contractor's Material and Test Certificate for Aboveground Piping, Contractor's Material and Test Certificate for Private Fire Service Mains, Fire pump acceptance test data report, and the like.
   2. Cleaning.
   3. Final acceptance by AHJ.
   4. Operating and Maintenance Manuals.
   5. Training of operating personnel.
   6. Record Drawings.
   7. Guaranty certificates.
   8. Letter of conformance.

3.20 LETTER OF CONFORMANCE

A. Provide letter of conformance and copies of manufacturers’ warranties and extended warranties with a statement in letter that fire suppression items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include letter of conformance and copies of manufacturers’ warranties and extended warranties in operating and maintenance manuals.

B. Warranties to begin at date of substantial completion.

END OF SECTION

BASIC FIRE SUPPRESSION MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
   1. Materials, installation and testing of pipe, tubing, sprinklers, fittings, and valves.
   2. Refer to Specification Sections for each system medium (i.e., standpipe and hose, fire suppression sprinkler systems, and the like) for product application.
   3. Hanging and bracing.
   4. Switches and supervisory devices.
   5. Fire suppression identification materials.
   6. Vibration and noise isolation.
   7. Provide electrical connections and wiring as required for a complete and operable system. Includes, but is not limited to air compressors, sump pumps, fire pumps, jockey pumps, pump controllers, and the like.

1.2 QUALITY ASSURANCE

A. Manufacturer's Inspection: Inspect flanges, fittings and field applied welds in accordance with manufacturer's standard written quality control procedure in accordance with the following techniques:
   1. Visual Method: Comply with MSS SP-55 except as otherwise indicated.

B. Welding Qualification: Qualify welding procedures, welders and operators in accordance with ANSI B31.1 for shop and project site welding of piping work.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for:
   1. Access panels.
   2. Each type of:
      a. Pipe for underground and aboveground systems.
      b. Fitting: flanged, welded, mechanical, threaded gasket.
      c. Coupling.
      d. Attachment: Concrete anchor, lag screw, through-bolt, and the like.
      e. Sprinkler: Upright, pendent, sidewall, special, and the like.
      f. Sprinkler guard.
      g. Sprinkler escutcheon.
      h. Sway Bracing: Fittings, attachment, pipe, angle iron, and the like.
      i. Fire caulking.
      j. Access panel.
      k. Miscellaneous: Solder, flux, glue, brazing filler.

B. Piping Materials List: Provide a typewritten list which schedules the piping materials to be used for each system as a function of applicable nominal pipe size ranges. Arrange schedule in outline form for each specific piping system, e.g., "Fire Sprinkler System," "Standpipe and Hose System," "Sway Bracing System," and the like. Include ASTM, ANSI, UL, FM Global or other numbers and other data as necessary to demonstrate compliance with requirements.

C. Test Procedure: Submit a typewritten checklist type of testing procedure indicating testing medium (i.e., water, air, nitrogen, and the like), pipe service, pipe and fitting type and classification, test pressure, pass/fail criteria and other pertinent data.

D. Maintenance Data: Submit maintenance data and parts list for each type valve. Include this data, product data, and certifications in operations and maintenance manual.

PART 2 - PRODUCTS

2.1 PRODUCT STANDARDS

A. Material and Equipment: Listed for its intended use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, or FM Global Approval Guide, new and of current manufacture.

B. Where pressures are expected to exceed 175 PSI due to pressure regulating valve failure, provide products for high pressure or extra high pressure service.

C. Provide per AHJ requirements.

D. References to product Specifications for materials are listed according to accepted base standards. Materials to meet latest approved versions of these standards.

E. See Section 21 00 00, Basic Fire Suppression where piping materials are approved for use.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3-foot lateral clearance from sides of electric switchgear panels. Do not route piping above electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such items.

B. Pressure Piping Routing:
1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.
2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
3. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 2 inches wherever furring is indicated for concealment of piping. Allow for insulation thickness. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
4. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.

C. Preparation:
1. Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions wherever piping of dissimilar metals are adjoined. Install unions in manner which will prevent galvanic action and inhibit corrosion.
2. Couplings: Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
3. Copper Tubing:
   a. Remove burrs from and clean outer surface of tube ends and inner surface of fittings.
   b. Pressurized Service:
      1) Unless otherwise indicated, wrought copper/bronze solder joint fittings complying with ANSI B16.22-1995.

D. Install products per UL listing or FM approval and per manufacturer's instructions.

3.2 PIPE AND PIPE FITTINGS

A. Pipe Sleeves:
1. Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1 inch above finished floor. Caulk pipes passing through floor with nonshrinking grout or approved caulking compound. Provide "Link-Seal" sleeve sealing system for slab on grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
3. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with nonshrinking caulking compound. Caulk/seal piping passing through fire-rated building assemblies with UL Listed or FM Approved fire-rated firestopping compound. Provide fire-rated assemblies per local AHJ requirements.

4. Beam Sleeves: Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Penetrations must be indicated on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Fire Suppression Drawings are diagrammatic. Offset piping as required to meet these limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.

B. Conform with applicable codes and industry standards.

C. Install uninsulated piping so that unrestrained direct contact with the structure or other system installations is avoided. Where contact with or passage through building or structural features cannot be avoided; firmly anchor piping to, or isolated from, the structure to prevent noise transmission and occurrence of physical damage. Install piping to be insulated with adequate clearance around piping to allow for placement of full thickness insulating material.

D. Expansion and Flexibility: Install work with due regard for expansion and contraction to prevent damage to the piping, equipment, building and its contents. Provide piping offsets, loops, approved type expansion joints, sway bracing, wire restraints, vertical restraints, flexible couplings or other means to control pipe movement and to minimize pipe forces.

E. Install piping in concealed spaces above finished ceilings. Obtain Architect's and Engineer's approval of exposed piping prior to installation.

F. Coordinate support of pipe 4 inches and larger with structural engineer.

G. Provide clearances around piping per NFPA 13.

H. Coordinate installation with other trades. Route piping as required to avoid building structure, equipment, plumbing piping, HVAC piping, lighting fixtures, electrical conduits and bus ducts and similar work. Final location of lighting will have priority over final sprinkler locations. Provide drains to trapped sections of system which result from such routing. Other trades take precedence for installation space.

3.3 ESCUTCHEONS

A. Install on exposed pipes passing through walls or floors.

3.4 PIPING AND EQUIPMENT REMOVAL

A. Piping and equipment removed as salvage by Owner to remain property of the Owner.

B. Comply with Division 02, Section "Site Demolition."

C. Remove as shown on drawings. Piping to be reused where shown. Dispose and remove excess piping equipment (and not identified by Owner as salvage).

3.5 ACCESSIBILITY

A. Installation of valves, gauges and equipment conveniently and accessibly located with reference to finished building for repairs, removal and service.

B. Access Panels: Label access panels with engraved nameplates indicating function of panel. Seton, Bakelite or approved. Nameplates to have 1/4-inch high white letters on red background, unless noted otherwise.

3.6 PAINTING

A. Machinery:
1. In a mechanical room, on the roof or other exposed areas, piping and equipment except sprinklers to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
2. See individual equipment specifications for other painting.

B. Structural Steel: Repair damage to structural steel finishes or the finishes of other materials damaged by cutting, welding or patching to match original.

C. Piping: Clean, primer coat, and paint exposed piping on the roof or at other exterior locations with two coats of paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.

3.7 ACCESS PANELS

A. Install ceiling or wall access panels to provide access to concealed valves, drains, drum drips, test connections and other fire suppression items needing service. Provide access panels at locations required or as specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

B. Where access panels are for service of valves, test connections, auxiliary drains, stencil the words "Fire Valve," "Inspector's Test Connection" or "Fire Auxiliary Drain " in 1/2-inch high capital letters on the outside of the panels.

3.8 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Contractors shall provide proper sizing when providing sleeves or core-drilled holes to accommodate their through penetrating items. All voids between sleeve or core-drilled hole and pipe passing through, shall be firestopped to meet the requirements of ASTM E814, in accordance with Division 7 Section "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, sprinklers, hose valves and piping and after units are water pressurized, test system to demonstrate capability and compliance with requirements. When possible, correct malfunctioning items at site, then retest to demonstrate compliance; otherwise, remove and replace with new items and proceed with retesting.

B. Inspect each installed item for damage to finish. If feasible, restore and match finish to original, except fire sprinklers, at site; otherwise, remove item and replace with new item. Feasibility and match to be judged by Architect. Remove cracked or dented items and replace with new items.

C. Fire sprinklers may not be reused, or cleaned, except for dusting. Replace damaged, field painted, oversprayed, overcoated or field coated sprinklers with new sprinklers of same manufacturer, model, finish, K-factor and performance characteristics. Where identical replacement sprinklers are not available, provide sprinklers of similar finish, style, K-factor and performance characteristics.

3.10 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each item of fire suppression equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices: valves, drains, pumps, standpipes, tanks, similar equipment.

3.11 ADJUSTING AND CLEANING

A. Adjusting: Relocate fire suppression identification device which has become visually blocked.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.12 CONNECTIONS TO EXISTING

A. Prior to connection of piping to existing as illustrated on Fire Suppression or Plumbing Drawings, field verify existing conditions and exact sizes and locations of existing piping. Provide additional offsets, transitions, joints, cut-ins, and replace portions of existing as required to facilitate connections of new as shown on Documents.

3.13 CAULKING

A. Provide Hilti FS-One High-Performance FireStop Sealant. ASTM E84-96, ICBO approved, Report No. ER-5071. Apply per manufacturer's recommendations.

3.14 CALCULATIONS

A. Hydraulic calculations include friction losses between the hydraulically most remote design area and the hydrant flow test pressure hydrant.

3.15 HANGERS

A. Space pipe hangers no more than 4 feet on center for exposed sprinkler pipe located 8’-0” or less above finished floor. Limit branch line overhangs to 4 inches or less.

3.16 DRAINS

A. Locate drain connections within 7 feet of floor. Provide piping capable of being fully drained.

3.17 FIELD SERVICES

A. Instruct the Owner in the operation of the sprinkler system.

3.18 THERMAL EXPANSION/CONTRACTION

A. On shop drawings, show loops for expansion or contraction where piping is subjected to thermal expansion/contraction.

END OF SECTION

SCHEDULES FOR WATER-BASED FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL

A. Material and Equipment: Listed for its intended use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, or FM Global Approval Guide, new and of current manufacture.

B. Refer to Specification Sections for each system medium (i.e., standpipe and hose, fire suppression sprinkler systems, and the like) for product application.

1.2 PIPE AND FITTINGS

A. General: Provide per AHJ requirements, and as a minimum per section 21 06 10 Schedules for Fire Suppression.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS FOR SPRINKLERS, STANDPIPES AND FIRE PUMP SYSTEMS

A. Aboveground Inside Building Piping:
   1. Pipe Size 2-Inch Diameter and Smaller: ASTM A53, ASTM A135, or ASTM A795; minimum CRR of 1.00 per UL listing or FM Global approval. Allied BLT/XL is not permitted.
   2. Pipe Size 2-1/2-Inch Diameter and Larger: ASTM A53, ASTM A135, or ASTM A795; minimum CRR of 1.00 per UL Testing or FM Global approved, wall thickness greater than Schedule 5 (Schedule 5 not approved).

B. Mechanical Couplings: FM Global approved; Victaulic, Gruvlok, or approved.

C. Mechanical Gaskets: EPDM, Vic-Plus, Grade E+, or approved.

D. Expansion Loop: Two flexible sections for hose and braid. Metraflex FireLoop, or approved.

E. Exposed pipe 8’-0” or less above finished floor shall be a minimum of Schedule 40.

2.2 SPECIALTY PRODUCTS FOR SPRINKLER, STANDPIPE AND FIRE PUMP SYSTEMS

A. Sway Bracing: From one manufacturer. Tolco, Afcon, or approved.

B. Attachments in Concrete: Compliant with International Codes Council Evaluation Service Acceptance Criteria AC-193 and AC308 for expansion, screw and adhesive anchors. UL listed and/or FM approved.

PART 3 NOT USED

END OF SECTION

FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This is a bidder design system. Contact City of Portland, Oregon's Fire Marshal's office or Authority Having Jurisdiction (AHJ) prior to bid to verify fire system requirements. Provide design compliant with codes as interpreted by AHJ.

B. Provide the following:
   1. Wet-pipe sprinkler system for remodel and new buildings.
   2. Window Sprinklers: Transoms. Glazing: On both sides of glazing where sprinklers are intended to serve as alternate means to achieve a 1-hour rating, provide closely sprinklers within 1 – foot of window at 6 – feet on center.

C. Refer to Architectural, Structural, Mechanical, Plumbing, Electrical, Fire Suppression, and Civil Drawings for additional information relating to the fire sprinkler system

1.2 SYSTEM DESCRIPTION

A. Provide coverage for the entire building. Field verify field conditions prior to submittal of bid. Adjust bid to provide protection features in accordance with applicable codes and interpretations by AHJ. Provide design and installation based on the more stringent requirements if AHJ requirements differ from Code.

B. Design Parameters:
   1. Increase remote design area for sloped roofs, and concealed areas per NFPA 13.

C. `Sprinkler system design to include a 10 percent pressure and flow cushion between system demand point and available water supplies.

D. Extend hydraulic calculations from hydraulically most remote design area back to location of pressure hydrant of flow test.

E. Develop cost-effective designs that may include the use of extended coverage sprinklers and design area reductions as allowed by NFPA 13.

1.3 FLOW TEST

A. Flow test information is provided for reference only.

B. Flow: 5000 GPM at a residual pressure of 46 PSIG. Design to residual pressure of 46 PSI per City of Portland.

C. Static Pressure: 71 PSIG. Design to static pressure of 57 PSI per City of Portland.

D. Location: SW Broadway and SW Mill (assured location).

E. Elevation: 135' assumed fire service elevation..

F. Date: June 2, 2009.

G. Information Provided By: Portland Water Bureau.

H. City of Portland may allow use of observed pressures for design. If observed pressures are used, the 10 percent cushion of Part 1.6 is required.

1.4 EXTRA STOCK

A. Provide extra sprinklers per code; provide suitable wrenches for each sprinkler type, and metal storage cabinet in riser room.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Specification Section 21 06 10 for additional product information.

2.2 PIPE AND FITTINGS

A. Flexible Sprinkler Hose Fittings: Braided stainless-steel hose. Flexhead, or approved.

2.3 SPRINKLERS

A. Finished Areas: Glass-bulb, recessed, quick-response pendent with white polyester finish, and white polyester escutcheon.

B. Nonfinished Areas: Glass-bulb, quick-response. Brass finish.

C. Dry: Recessed, glass bulb, quick-response, white polyester finish with white escutcheon.

D. Provide flexible sprinkler connection fittings for pendent sprinklers to comply with building code and ASCE 7 seismic requirements for ceilings.

E. Window Sprinklers: Use listed window sprinklers or sprinklers with a similar discharge pattern to window sprinklers. Submit proposed head choice, with plot of sprinkler discharge pattern, and spacing for approval to AHJ.

F. Provide guards for sprinklers located under ducts or other obstructions or for sprinklers located less than 8'-0" above finished floor or where subject to mechanical injury.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Center sprinklers in the middle or quarter points of suspended ceiling tile.

B. Apply strippable tape or paper cover to ensure sprinklers do not receive field paint finish. Remove upon completion of painting.

C. Contractor shall follow Architect's guidelines for acoustical sensitive areas and comply with sections.

END OF SECTION

PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Includes modifying and removing existing and providing new plumbing in accordance with all sections of the specifications and City of Portland, Oregon.

B. Work includes but is not limited to:
1. Aboveground soil, waste and vent piping within buildings, including soil stacks, vent stacks, horizontal branches, traps, and connections to fixtures and drains.
2. Underground building drain piping including mains, branches, traps, connections to fixtures and drains, and connections to stacks, terminating at connection to sanitary sewers 5 feet outside foundation wall.
3. Conductor or interior rainwater piping from roof drains to storm building drain.
4. Storm overflow piping from overflow drains.
5. Domestic cold water piping.
6. Domestic hot water piping.
7. Domestic hot water re-circulating piping.
8. Plumbing fixtures: See Section 22 40 00, Plumbing Fixtures, and schedule for types.
9. Furnishing and installation of access doors required for work furnished by this Section.
10. Furnishing and installing of sleeves, inserts and anchorage required for the installation, which are embedded in work of other trades. Sleeve, wrap and seal piping in concrete.

C. Related Work Specified Elsewhere:
1. Division 1 – General Requirements.
2. Division 7 – Thermal and Moisture Protection.
3. Section 09 91 00 Paint.
4. Division 26 - Electrical

1.2 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 22:
1. AHJ Authority Having Jurisdiction
2. ANSI American National Standards Institute
3. ARI Air-Conditioning & Refrigeration Institute
4. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
5. ASME American Society of Mechanical Engineers
6. ASTM American Society for Testing and Materials
7. ASSE American Society of Sanitary Engineering
8. AWWA American Water Works Association
9. CSA Canadian Standards Association
10. CISPI Cast Iron Soil Pipe Institute
11. CSA Canadian Standards Association
12. ETL Electric Testing Laboratories
13. FM FM Global
14. HVAC Heating, Ventilating and Air Conditioning
15. ISO International Organization of Standards
16. LEED Leadership in Energy and Environmental Design in Association Green Building Council
17. MSS Manufacturers Standardization Society
18. NEC National Electric Code
19. NEMA National Electrical Manufacturers Association
20. NFPA National Fire Protection Association
21. NSF National Sanitation Foundation.
22. OESC Oregon Electrical Specialty Code.
23. OFC Oregon Fire Code.
24. OMSC Oregon Mechanical Specialty Code.
25. OPSC Oregon Plumbing Specialty Code.
26. OSSC Oregon Structural Specialty Code.
27. OSHA Occupational Safety and Health Administration
28. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
29. UL Underwriters Laboratories Inc.

B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

1.3 QUALITY ASSURANCE

A. Where Contract Documents are at variance with applicable codes governing work, code and local jurisdiction requirements take precedence, and include cost necessary for code compliance or local jurisdiction compliance in bid price. Machinery and equipment to comply with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements.

B. Plumbing Drawings: Drawings are intended to be diagrammatic and are based on one manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than basis of design, including but not limited to architectural, structural, electrical, HVAC, fire sprinkler, and plumbing.

C. Requirements: As a minimum requirement, work in accordance with following rules and regulations and applicable laws:
1. NFPA.
2. OSHA.
3. Barrier free access per Oregon Structural Specialty Code.
4. Oregon Fire Code.
5. Oregon Mechanical Specialty Code.
6. Oregon Plumbing Specialty Code.
7. Oregon Structural Specialty Code.

D. Permits and Inspections:
1. Unless otherwise distinctly hereinafter specified, apply and pay for necessary permits, plans check, and inspections required by city of Portland.
2. Refer to General and Supplementary Conditions for payment of water and sewer service connection fees.
3. Obtain certificates of inspection from city of Portland and deliver to Owner before final acceptance.
4. Each trade to consult local building department and utility companies prior to commencement of work to ascertain existence and location of existing underground utilities. Protect existing service against damage and interruption of use, and reroute as may be necessary to accomplish new work. Include costs for materials and installation for rerouting as specified for new work in bid price.

E. Regulatory Requirements: UL and CSA Compliance. Provide units which are UL, ETL, and CSA listed.

1.4 SEQUENCING AND SCHEDULING

A. For proper execution of work cooperate with other trades as needed.

B. To avoid installation conflicts, thoroughly examine complete set of Contract Documents. Resolve conflicts with Architect and Owner's representative prior to fabrication and installation.

C. Prior to installation of equipment requiring electrical connections, examine manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that electrical characteristics indicated in Contract Documents are consistent with electrical characteristics of actual equipment being installed. When inconsistencies occur request clarification from Architect and Owner's Representative.

1.5 COORDINATION DOCUMENTS

A. Prepare and submit coordinated layout drawings to Architect and Owner’s Representative prior to construction, to coordinate installation and location of ductwork, grilles, diffusers, piping, fire sprinklers, plumbing, lights, and electrical services. Composite Drawings show services on single sheet. Key Drawings to structural column identification system, and progressively number. Prior to completion of Drawings, coordinate proposed installation with architectural and structural requirements, and other trades (including plumbing, HVAC, fire protection, electrical, ceiling suspension, and tile systems), and provide reasonable maintenance access requirements.

B. Prepare Drawings as follows:
   1. Prepare Drawings to accurate scale of 1/4 inch = 1 foot or larger on Mylar sheets or AutoCAD. Drawings are to be same size as Contract Drawings and to indicate location, size and elevation above finished floor of plumbing equipment and piping. Drawings to also indicate proposed ceiling grid and lighting layout as shown on electrical drawings and reflected ceiling drawings.
   2. Review and revise as necessary section cuts in Contract Drawings after verification of field conditions.
   3. Indicate plumbing system piping including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   4. Piping that must be graded to have right-of-way over more flexible items. Drawings also to indicate proposed ceiling grid and lighting layout as shown on electrical drawings and reflected ceiling drawings and HVAC equipment, ductwork and piping.
   5. Drawings are to incorporate Addenda items and change orders.
   6. Distribute drawings to trades and provide additional coordination as needed.

C. Advise Architect, in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Final coordination drawings with appropriate information added to be submitted as Record Drawings at completion of project.

1.6 EXISTING SOILS CONDITIONS

A. Examining existing soils conditions before submitting bid on work. No additional allowance will be granted due to lack of information for existing conditions of subsurface soils.

B. Submission of a bid will be considered acknowledgment of review/understanding of project geotechnical soils report.

PART 2 - PRODUCTS

2.1 HAZARDOUS MATERIALS

A. Do not use products containing asbestos, lead, arsenic, or any other material defined by EPA as hazardous to human or animal life.

2.2 MATERIALS

A. Materials, equipment, and fixtures used for construction are to be new, the latest products as listed in manufacturer's printed catalog data and are to be approved for use by State of Oregon. Equipment supplier is responsible for obtaining state, county, and city acceptance on equipment not UL approved or not listed for installation.

B. Fixtures, piping and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

A. Install equipment having components requiring access (i.e., drain pans, drains, control operators, valves, motors, drives, and the like) so that they may be serviced, reset, replaced or recalibrated and the like, by service people with normal service tools and equipment. Notify Architect in writing if equipment or components are shown in such a position that above cannot be accomplished.

B. Install equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment, examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect [Engineer] prior to proceeding with installation. This includes proper installation methods and sequencing, in coordination with other trades and disciplines.

C. Earthwork:
   1. Refer to Division 31.
   2. Perform excavation and backfill for installation of plumbing work in accordance with OPSC.

D. Firestopping:
   1. Coordinate with Drawings the location of fire rated walls, ceilings and floors. When these assemblies are penetrated, seal around piping, equipment, and the like, with approved firestopping material.
   2. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

3.2 NOISE AND VIBRATION

A. Install vibration isolators, flexible connectors, expansion joints, and measures required to prevent noise and vibration from being transmitted to occupied areas. Select equipment to operate within noise coefficient (NC) design level for particular type of installation in relation to its location.

B. After installation, make proper adjustments to reduce noise and vibration to acceptable levels as defined by Architect.

C. All piping between classrooms shall be provided with vibration sleeves to prevent noise transmission.

D. All piping over concert halls to be wrapped double width normal insulation. Insulate sanitary sewer lines with 2” thick insulation.

3.3 SEISMIC CONTROL

A. Provide per Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.

3.4 REVIEW BY ENGINEER

A. Notify Architect/Engineer, in writing, at following stages of construction so that Architect and Owner's Representative may, at their option, visit site for review and construction observation:
   1. Underground piping installation prior to backfilling.
   2. Prior to closing walls.
   3. When ceiling installation is started.
   4. When main systems, or portions of, are being tested and ready for inspection by city of Portland.

3.5 OPERATING DURING REMODEL

A. During remodeling existing structure will not be occupied.

B. Shut down of services affecting other buildings will be coordinated with facilities management. Perform actual transfer to new service at off-peak time, as coordinated with Owner. Once changeover is started, pursue it to its completion, to keep interference to a minimum.

3.6 DEMOLITION

A. It is intent of these documents to provide necessary information and adjustments to plumbing system required to meet code, and accommodate installation of new work.

B. Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.

C. Unless otherwise directed, equipment, fixtures, or fittings being removed as part of the demolition process shall be removed from job site.

3.7 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

B. Maintain design intent where equipment other than as shown in Contract Documents is provided. Where equipment requires piping arrangement, control diagrams, or sequencing different from that indicated in Contract Documents, provide electrical motors, wiring, controls, or other required electrical components at no additional cost to Owner.

3.8 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials and equipment in environmentally controlled location to prevent damage and deterioration. Store in original container which identifies manufacturer's name, brand and model number. Do not store indoor equipment outdoors unless provided with a waterproof protective cover.

B. Replacement: In event of damage, immediately make repairs and replacements necessary.

3.9 CLEANING

A. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated by this work.

3.10 INSTALLATION

A. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level, firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

B. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of plumbing systems.
   2. Furnish sufficient dry nitrogen for pressure testing under manufacturer's supervision.
   3. Provide and install pump impellers to obtain design capacities. Coordinate exact requirements with balancing firm.

3.11 PAINTING

A. Refer to Section 09 91 00 “Painting”.

3.12 CUTTING AND PATCHING

A. Refer to Section 01 73 29 "Cutting and Patching."

3.13 ACCEPTANCE

A. System can not be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
   1. Testing and balancing reports.
   2. Cleaning.
   3. Building department final sign-off document.
   4. Operating and Maintenance Manuals.
   5. Training of operating personnel.
   6. Record Drawings.
   7. Guaranty certificates.
   8. Start-up commissioning document.

3.14 LETTER OF CONFORMANCE

A. Provide letter and copies of extended warranties with a statement in letter that Plumbing items were installed in accordance with manufacturer's recommendations. Include letter of conformance and warranties in operating and maintenance manuals.

B. Warranties to begin at date of building completion. Contractor shall coordinate date of building completion with facilities management and Architect.

END OF SECTION

PLUMBING PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Piping Materials List: Provide a typewritten list which schedules the piping materials to be used for each system as a function of applicable nominal pipe size ranges. Arrange schedule in outline form for each specific piping system, e.g., "Domestic Water System," "Soil, Waste, and Vent Piping System," and the like. Include ASTM, ANSI or other numbers and other data as necessary to demonstrate compliance with requirements.

B. Test Procedure: Submit a typewritten checklist type of testing procedure indicating testing medium (i.e., water, air, nitrogen, and the like), pipe service, pipe and fitting type and classification, test pressure, pass/fail criteria and any other pertinent data.

PART 2 - PRODUCTS

2.1 PIPING - GENERAL

A. Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service, as indicated in other Division 22 Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

B. Product marking: Each item shall be clearly marked with name brand and manufacturer process, heat number, ASTM and UL/FM numbers.

C. Product shall be certified for use in the State of Oregon.

2.2 STEEL PIPE

A. ASTM A53, Schedule 30, 40, and 80. Black or hot dipped zinc coated galvanized, welded or seamless, Grade B.

2.3 COPPER TUBE

A. Domestic Water Service: Type "L" hard drawn, ASTM B88, continuously marked with blue stripe.

2.4 CAST IRON PIPE

A. CISPI HS-74, ASTM A74, hub-and-spigot, service weight.

B. CISPI 301, ASTM A888 No-Hub.

C. Piping shall be marked with CISPI trademark “CI”.

D. Manufacturer: Tyler or AB&I.

2.5 CROSS-LINKED POLYETHYLENE TUBING, FITTINGS AND ACCESSORIES

A. Tubing - Cross-linked polyethylene (PEX): ASTM F876 and F877, color coded for service type.

B. Fittings: ASTM F1960.

C. Manufacturers: Uponor, Zurn or Rehau.

2.6 FITTINGS FOR STEEL PIPE

A. Malleable Iron: Class 150 and Class 300, ANSI B16.3, threaded or flanged joint.

B. Cast Iron: Class 125 and 250, ANSI B16.3, threaded or flanged joint.

C. Carbon Steel: Long radius, standard weight or extra strong ANSI B16.9, bevel welded joint.

2.7 FITTINGS FOR DOMESTIC COPPER TUBE

A. Seamless, wrought copper: ANSI B16.22. No cast copper fittings.

B. Joints:
   1. Lead free solder joint; ASTM B-32, ASTM B-828 and NSF-61.
   2. Large Brazed Joint: BCup-5, containing no cadmium.

C. Pipe Sizes 2-1/2-inch and Larger: Flanged or roll-grooved.
   1. Roll grooved: ISO 9001 certified manufacturer, Victaulic, Anvil or Shur-Joint.

2.8 FITTINGS FOR CAST IRON PIPE

A. No-Hub Cast Iron Drainage Pipe Fittings:

1. Service weight: CISPI 301, ASTM A-74, Tyler “Ty-seal”.
2. No-hub: CISPI 301, ASTM-A-888.
3. Coupling: Standard couplings with neoprene gasket and stainless steel corrugated shield ASTM C-564, CISPI 310, Husky, Tyler or Clamp-All.

2.9 UNIONS

A. Steel Pipe Union: 150 PSI malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe.

B. Copper Pipe Union: 200 PSI working pressure. Bronze body, solder or grooved ends. Pipes 2 inches and under use ground joint, pipes 2-1/2 inches and larger use flanged face or grooved ends.

C. Insulating Unions: 250 PSI working pressure. Pipe ends and material to match piping. Electric current below 1 percent of galvanic current. Gasket material as recommended by manufacturer.

D. Manufacturer: EPCO, Mueller or Flagg.

2.10 ESCUTCHEONS

A. Brass material, chrome plated finish. Size sufficient to cover pipe openings through wall, floor or ceiling. Set screw or spring to secure to pipe. Coordinate opening sizes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Work shall be performed by licensed journeyman plumbers and apprentices, no exceptions.

B. All work and materials shall conform to rules and regulations of the City of Portland, Oregon.

3.2 FIELD QUALITY CONTROL

A. Inspection:
1. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
2. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect. Remove cracked or dented units and replace with new units.

3.3 ADJUSTING AND CLEANING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of painting, insulation, or coatings, if any. Comply with the preparation requirements of Section 22 05 53, Identification for Plumbing Piping and Equipment, and Section 22 07 00, Plumbing Insulation, as applicable. Flush out water filled or drainage piping systems with clean water, and flush other piping systems with dry air or nitrogen after completing required tests. Inspect each segment of each system for completion of joints, supports, and accessory items.

B. Inspection: Inspect pressurized piping in accordance with the procedures of ANSI B31.9.

3.4 PROTECTION

A. Protect piping from damage. Replace damaged items with new.

B. Do not store materials on the floor or ground. Materials shall be stored in an environmentally controlled location.

3.5 ESCUTCHEONS

A. Install on exposed pipes passing through walls or floors, and on fixture stops and waste connections to wall.

3.6 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

3.7 PLUMBING PIPING SYSTEM CLASSIFICATION

A. Domestic cold, hot and hot water re-circulating.
   1. All sizes: Type ‘L’ copper.
   2. Fittings 2 1/2 inch and larger shall be roll-grooved or flanged.
   3. Joints 1 1/2 inch and larger shall be brazed.
   4. No galvanized pipe or nipples allowed.
   5. All piping shall be insulated, including branch lines and shut-off valves.
   6. Branch lines to fixtures shall be plenum rated PEX tubing and fittings as shown on drawings. Do not insulate tubing.

B. Trap primer lines:
   1. Aboveground: Insulated Type ‘L’ copper or PEX tubing.

C. Sanitary, Drainage, Waste and Vent:
   1. Aboveground: Service weight cast iron or No-Hub Cast iron.
   2. Belowground: Service Weight Cast Iron.

D. Storm Drain, Overflow and Interior Rainwater Loaders:
   1. Underground: Service weight cast iron.
   2. Aboveground: Service weight or no-hub cast iron.
   3. All aboveground horizontal piping shall be insulated.

E. Equipment or condensate drains:
   1. Type ‘L’ copper.

END OF SECTION

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation and testing of valves, including the following:
   1. Ball valves.
   2. Swing check valves.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: ISO 9001 Certified.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of valve.

B. Maintenance Data: Submit maintenance data and parts list for each type valve. Include this data, product data, and certifications in maintenance manual.

PART 2 - PRODUCTS

2.1 VALVES - GENERAL

A. General:
   1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
   2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn.

B. Service:
   1. Domestic Hot and Cold Water Shutoff and Isolation Valves - Pipe Sizes 3 Inches and Smaller: Ball valve, or Gate valve.

C. Manufacturers: Apollo, Crane, Red/White (commercial grade), Mueller, Conbraco, Nibco, Stockham, Hammond, Watts, Milwaukee, or Victaulic.

2.2 BALL VALVES

A. 3 Inches and Smaller: MSS-SP10, 600 PSI, bronze body, full port, bronze trim, brass ball, two-piece construction, for sizes 1/2 inch to 1 inch, 3 piece construction for 1 1/2 inches and larger. RP TFE seats and seals soldered ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

B. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter for each valve that must be installed with stem below horizontal plane.

C. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

D. Seats: Renewable seats, except where otherwise indicated.

3.2 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification. Tag valves per Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.3 PROTECTION

A. Protect valving from damage. Replace damaged items with new.

B. Do not store materials on the floor or ground. Materials shall be stored in an environmentally controlled location.

3.4 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, shock arrestors, and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

END OF SECTION

HANGERS AND SUPPORTS FOR PLUMBING AND PIPING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Material and installation of supports, anchors and sleeves including: horizontal piping hangers and supports; vertical piping clamps; hanger rod attachments; building attachments; saddles and shields; miscellaneous materials; equipment supports; anchors; equipment supports; wall and floor sleeves; and escutcheon plates.

1.2 QUALITY ASSURANCE

A. Manufacturers: ISO 9001 Certified.

B. Regulatory Requirements:
1. Provide pipe hangers and supports whose materials, design and manufacture comply with MSS SP-58, "Pipe Hangers and Supports - Materials, Design and Manufacture," latest edition.
2. Select and apply pipe hangers and supports complying with MSS SP-69, "Pipe Hangers and Supports - Selection and Application," latest edition.
3. A copy of the above-referenced standards on the construction site at all times.

C. Seismic: Provide per Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Hanger Manufacturers: B-Line, Elcen Metal Products Co., F&S Control, Globe, Kindorf, Kinline, Michigan, Superstrut, Unistrut or Power-Strut.

1.3 SUBMITTALS

A. Submit the following:
1. Manufacturer's technical product data, including installation instructions, for each type of support, anchor and sleeve. Include UL approval drawing from manufacturer for each different pre-engineered firestop assembly.
2. Assembly type shop drawings for each type of sleeve, indicating dimensions, weights, required clearances, and methods of assembly of components.
3. Shop drawings for each individual roof pipe curb assembly, indicating number and location of each pipe or conduit which is to pass through the curb. Indicate pipe insulation requirements.

PART 2 - PRODUCTS

2.1 PIPING HANGERS AND SUPPORTS

A. General:
1. Horizontal Piping Hangers and Supports-Horizontal and Vertical Piping, and Hanger Rod Attachments: Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for uninsulated copper piping systems.
2. Building Attachments: Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.
3. Saddles and Shields: Factory fabricated saddles or shields under piping hangers and supports for insulated piping. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12 inches in length (4-inch pipe and larger to be three times longer than pipe diameter).
4. Anchor Bolts: Heavy duty, drilled in concrete, expansion wedge bolt ICBO rated.
5. Concrete Inserts: MSS Type 18.
6. Beam clamp: MSS Type 19 with retainer clip.
7. Side beam clamp: MSS Type 20.
8. Pre-manufactured pipe trapezes: Powerstrut PS-200-273 double ‘U’ shaped 12 gauge channel, ASTM A-570 – Grade 33.

B. Pipe Hangers: Adjustable swivel ring hanger, UL listed, MSS Type 10.

C. Pipe Hangers: Adjustable Clevis Type, UL listed, MSS Type 1.

D. Vertical Riser Clamps: Steel, UL listed, MSS Type 8.

E. Plumbers Tape: Not permitted as pipe hangers or pipe straps.

F. Hanger Rods: Carbon Steel, ASTM-510, Continuous thread.

G. Hanger Rod Attachments:
1. Steel Turn Buckle: MSS Type 13.
2. Clevis: MSS Type 14.
3. Swivel Turn Buckle: MSS Type 15.
4. Eye Socket: MSS Type 16.
5. Eye Nuts: MSS Type 17.

2.2 WALL AND FLOOR SLEEVES

A. General:
1. "Link-Seal" Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Provide Type S unless otherwise noted. Thunderline Corporation, or approved.
2. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.
3. Insulating Caulking: Eagle, Pitcher Super 66 high temperature cement, or approved.
4. Fabricated Accessories:
a. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
b. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:
1) Sleeve Size 4 Inches in Diameter and Smaller: 18 gauge.
2) Sleeve Sizes 5 to 6 Inches: 16 gauge.
3) Sleeve Sizes 7 Inches and Larger: 14 gauge.
c. Fire-Rated Safing Material:
1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985F and K value of 0.24 at 75F.
2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100F to 1200F service with K value of 0.40 at 150F.

2.3 ANCHORS

A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer.

B. Manufacturers: Anchor-It, Hilti Hit System, Epcon System, or Power Fast System.

2.4 ACOUTSTICAL SUPPORTS

A. Provide resilient sleeves, hanger and supports for all pipes passing between classrooms, hall or theatres.

B. Refer to Section 22 05 48.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine the Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

B. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

3.2 INSTALLATION

A. Building Attachments: Install within concrete or on structural steel or wood. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

B. Hangers and Supports:
   1. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers. Maximum spacings: MSS SP-69. 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 support piping from other piping.
   2. Support fire protection piping independently of other piping.
   3. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
   4. Allow controlled movement of piping systems to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
   5. Piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
   6. Insulated Domestic Water Piping: Provide protection saddles where insulation without vapor barrier. Provide protection shields on insulated piping where insulation with a vapor barrier is indicated.
   7. Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3 feet lateral clearance from all sides of electric switchgear panels. Do not route piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact pipe routing to provide proper clearance with such items.
   8. Hanger Spacing: Install per OPSC.

C. Anchors: Install at ends of principal pipe runs where indicated on Drawings. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

D. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.

E. "Link-Seal" Pipe Sleeves: Install at exterior wall piping penetrations. For penetrations below grade provide Schedule 40 steel sleeve with 1-inch, continuously welded, "weep ring" centered on length of sleeve.

F. Fabricated Pipe Sleeves:
   1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeves not to be more than 1 pipe size larger than piping or piping plus insulation size.
   2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1/4 inch above floor finish and, where floor surface drains to a floor drain, extend floor sleeve 3/4 inch above floor finish.
   3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
   4. Seal each end airtight with a resilient nonhardening sealer.

G. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
   1. Install fabricated pipe sleeve.
   2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.

H. Piping penetrations through fire-rated (1 to 3 hour) assemblies: Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.

3.3 ADJUSTING AND PAINTING

A. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.

B. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

3.4 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E84.

B. Manufacturers: Hilti or Proset.

END OF SECTION

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials and installation of seismic restraint devices and related items.

1.2 SEISMIC CONTROL AND RESTRAINT

A. Plumbing Equipment:
   1. Brace or anchor plumbing equipment to resist a horizontal force acting in any direction in accordance with OSSC requirements.
   2. Provide any restraints noted on Drawings for Division 22 work.

B. Anchorage:
   1. Where anchorage details are not shown on Drawings, the field installation subject to approval of the project structural engineer.
   2. In other cases, retain a professional structural engineer licensed in the state in which the work will be done to provide shop drawings of seismic bracing for ductwork/equipment/water heaters. Professional engineer to design and provide wet stamped (sealed) shop drawings for equipment, water heaters, and piping seismic bracing. Submit shop drawings and calculations along with equipment submittals.
   3. The restraints which are used to prevent disruption of the function of the piece of equipment because of the application of the horizontal force to be such that the forces are carried to the frame of the structure in such a way that the frame will not be deflected when the apparatus is attached to a mounting base and equipment pad, or to the structure in the normal way, utilizing the attachments provided. Secure equipment to withstand a force in any direction.

C. Specify the seismic bracing and anchorage of piping in Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.

D. Provide earthquake bumpers to prevent excessive motion during starting and stopping of equipment and for earthquake bracing. Install bumpers after equipment is in operation to allow proper placement and alignment and ensure that bumpers are not engaged during normal system operation.

1.3 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with building systems. Coordinate plan dimensions of final selections and plumbing equipment with size of housekeeping pads.

B. Supply and install any incidental materials needed to meet the requirements stated herein.

1.4 SUBMITTALS

A. Provide a complete description of products to be supplied including product data, dimensions and specifications. Provide installation instructions for each product.

B. Provide a complete tabulation showing for each piece of vibration isolator supporting equipment the following:
   1. The equipment identification mark.

C. Provide fabrication/shop drawings of steel rails, inertia bases, steel base frames, reinforcing, vibration isolator mounting attachment method, unitary straps and location of equipment attachment bolts.

D. Provide structural calculations for isolator seismic restraint for plumbing equipment including, but not limited to boilers, roof curbs, fuel storage tanks, pumps, water heaters, storage tanks, sealed by a professional structural engineer, registered in the state of Oregon.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS FOR PIPING

A. Use the document "*Seismic Restraints Manual Guidelines for Mechanical Systems*." Secure piping and the like to withstand a force in any direction.

B. Sway bracing is not required for pipes that are installed on very short individual hangers (12 inches or less).

C. Secure plumbing piping bracing at every fourth hanger transversely and every eighth hanger longitudinally.

D. As approved by code authority, use a bracing system manufactured by Superstrut, Mason, or Pipe Shields Inc., or approved.

PART 3 - EXECUTION

3.1 APPLICATION

A. General:
1. Install flexible pipe connections (FPC) at pipe connections to vibration isolated equipment. Included, but not be limited to, pumps, emergency generators, commercial washer/dryers, and the like.
2. Isolate miscellaneous pieces of plumbing equipment, i.e., storage tanks and expansion tanks from the building structure by NP or HN isolators.
3. Under no circumstances destroy isolation efficiency by bolting the isolators to the roof or floor or equipment. If bolting is necessary, provide rubber grommets and washers to isolate the bolt from the base plate.
4. Building Penetrations: Isolate water piping penetrating wall, ceilings, floors or shafts from the structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe or duct at equipment room wall.
5. Hot and Cold Plumbing Pipes: Isolate hot and cold water piping in plumbing chases and walls behind plumbing fixtures, which are adjacent to occupied areas, from the structure by a piping isolator, Cush-A-Strip S-716, or a 6-inch section of 3/8-inch thick foamed plastic between the hanger and pipe. Contractor's Option: Acousto-Plumb System using plastic bushings.

3.2 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, shock arrestors, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

END OF SECTION

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials and installation of plumbing systems identification.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.

B. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2- by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

PART 2 - PRODUCTS

2.1 PLUMBING IDENTIFICATION MATERIALS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Manufacturers: Allen Systems, Inc., W. H. Brady Co., Signmark Division, Industrial Safety Supply Co., Inc. Seton Name Plate Corporation, Safety Cal, or Kolbi.

2.2 PLASTIC PIPE MARKERS

A. Provide one of the following:
   1. Snap-on Type: Manufacturer's standard preprinted, semi-rigid snap-on, color-coded pipe markers.
   2. Pressure-Sensitive Type: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure sensitive, vinyl pipe markers.

B. Small Pipes: For external diameters less than 6 inches (including insulation, if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   1. Snap-on application of pretensioned semi-rigid plastic pipe marker.
   2. Adhesive lap joint in pipe marker overlap.
   3. Laminated or bonded application of pipe marker to pipe (or insulation).
   4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

C. Large Pipes: For external diameters of 6 inches and larger (including insulation, if any), provide either full-band or strip-type pipe markers, but not narrower than three times letter height (and of required length), fastened by one of the following methods:
   1. Laminated or bonded application of pipe marker to pipe (or insulation).
   2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inches wide; full circle at both ends of pipe marker, tape lapped 3 inches.
   3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

D. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.3 VALVE TAGS

A. Brass Valve Tags: Polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2 inch high, and with hole for fastener. 1-1/2-inch diameter tags, except as otherwise indicated.

B. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.

C. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include center hole to allow attachment.

2.4 VALVE SCHEDULE FRAMES

A. General: For each page of a valve schedule, provide glazed display frame with removable mounting as appropriate for wall construction upon which frame is to be mounted. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.5 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, Federal Specification L-P-387, in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for plumbing fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch for units up to 20 sq.in. or 8 inches in length; 1/8 inch for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.6 PLASTIC EQUIPMENT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded equipment markers. Conform to the following color code:
1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.

B. Nomenclature: Match terminology used on drawing schedules as closely as possible.

C. Size: Provide approximate 2-1/2- by 4-inch markers for control devices, dampers, and valves; and 4-1/2- by 6-inch markers for equipment.

2.7 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Boiler No. 3, Circulation Pump No. 42, Cold water riser No. 12, and the like).

2.8 CEILING TILE LABELS

A. Machine-generated, adhesive-backed tape labels with black letters on clear tape.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. Install pipe markers on each system and include arrows to show normal direction of flow.

B. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels and plenums), and exterior nonconcealed locations, in locations as follows:
   1. Near each valve and control device.
   2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
   3. Near locations where pipes pass through walls or floors/ceilings, or enter nonaccessible enclosures.
   4. At access doors, manholes and similar access points which permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced intermediately at maximum spacing of 20 feet along each piping run, except reduce spacing to 10 feet in congested areas of piping and equipment, i.e., mechanical rooms.

3.3 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system. Exclude check valves, valves within factory fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, shutoff valves at plumbing fixtures, and similar rough-in connections of end use fixtures. List each tagged valve in valve schedule for each piping system.

B. Install mounted valve schedule in each mechanical room.

C. Provide color-coded round button on ceiling tile below valve location.

3.4 PLUMBING EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices: Pumps, compressors, and similar motor driven units, water heaters, tanks and pressure vessels, filters, water treatment systems and similar equipment.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Relocate any plumbing identification device which has become visually blocked.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION

PLUMBING SYSTEMS INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Piping and Equipment Insulation: Materials and installation of insulation, jackets and accessories for the following applications:
   1. Hot and cold domestic water piping systems.
   2. Horizontal rainwater leaders, overflow roof leaders and storm drain water piping systems.
   3. Make-up water piping systems.
   4. Underside of roof drain and overflow drain bodies.

1.2 QUALITY ASSURANCE

A. Qualification of Workers: Use proficient journeyman insulators and supervisors in the execution of this portion of the work to ensure proper and adequate installation of insulation throughout. A firm with at least 5 years successful installation experience on projects with installations similar to that required for this project.

B. Compliance with Specifications:
   1. Whenever required during progress of the work, furnish proof acceptable to the Owner that items installed are equal to or exceed requirements specified for this work.
   2. In the event such proof is not available, or is not acceptable to the Owner, the Owner may require the Contractor to remove the item or items and replace with material meeting the specified requirements and to repair damage caused in the removal and replacement, at no additional cost to the Owner.
   3. Install per manufacturer's written instructions.
   4. As a minimum, comply with appropriate state energy code or other applicable codes.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of insulation, jacket, glue, paint, fitting cover, and accessory. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each piping, equipment and duct system requiring insulation.

1.4 PRODUCT HANDLING

A. Protection: Use means necessary to protect insulation materials before, during and after installation.

B. Replacements: In the event of damage, immediately make repairs and replacements necessary.

1.5 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a flame spread of 25, fuel contributed of 50 and smoke developed of 50 as tested by ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with the requirements of UL "Pipe and Equipment Coverings R5583 400 8.15."

C. Test duct insulation in accordance with ASTM E84 and bear the UL label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Piping: Armacell LLC Armaflex, Certainteed, Imcoa, Johns Manville, Knauf, Nomaco, Owens-Corning, PPG, or approved.

2.2 TYPE 1, FIBERGLASS PIPE INSULATION

A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
   1. Thermal Conductivity Value: 0.27 at 75F.
   2. Maximum Service Temperature: 850F.
   3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples or vapor barrier mastic as needed.

2.3 JACKETING

A. PVC Plastic Fitting Covers: Schuller Zeston 2000. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

B. Canvas Jacket: UL listed fabric, 6 oz/sq.yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

C. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.

D. Stainless Steel Jacket: Type 304 stainless steel, 0.010 inch, (smooth/corrugated) finish.

2.4 ACCESSORIES

A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments.

2.5 PIPE FITTING INSULATION COVERS

A. PVC preformed molded insulation covers as manufactured by Zeston.

2.6 CANVAS JACKET

A. UL listed fabric, 6 ounce/square yard., plain weave cotton treated with dilute fire retardant lagging adhesive.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Do not apply insulation until pressure testing of the ducts has been completed. Do not apply insulation until the duct has been inspected.

B. Examine areas and conditions under which duct insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to be insulated.

3.3 INSTALLATION

A. Insulation: Continuous through walls, floors, partitions except where noted otherwise.

B. Valving shall be insulated.

C. PEX tubing does not require insulation.

D. Piping and Equipment:
1. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that the insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until the piping has been leak tested and has passed such tests. Do not insulate chiller manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
2. Cover insulation on pipes above ground, outside of buildings, with aluminum jacketing. Position seam on bottom of pipe.
3. Valving will be insulated. Provide extended handles on ball valves

3.4 PROTECTION AND REPLACEMENT

A. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

3.5 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate the vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

3.6 LABELING AND MARKING

A. Provide labels, arrows and color coding on piping per Section 22 05 53, Identification for Plumbing Piping and Equipment. Attach labels and arrows to the jacketing.

3.7 PIPING SURFACES TO BE INSULATED

Item to be Insulated:	System Insulation Type:	Pipe Size:	Insulation Thickness:
Domestic hot water and hot water re-circulation piping above grade.	1	All	1"
Domestic cold water above grade.	1	All	1/2"
Rain/overflow conductors and storm drain, above grade horizontal piping.	1	All	1/2"

Note: Insulation thickness shown is a minimum. If state codes or AHJ require additional thickness, provide insulation thickness per code and AHJ requirements.

3.8 ROOF DRAIN/OVERFLOW DRAIN UNDERBODIES AND PIPING

A. Above grade, cover horizontal existing and new roof drain and overflow drain piping with sectional pipe covering. Cover underside of drain body with insulation; attached with adhesive and supported externally with 26-gauge galvanized flat strapping anchored to structure.

3.9 OSSC BARRIER FREE ACCESSIBLE LAVATORIES/SINKS

A. Install lavatory/sink insulation kit.

3.10 INSULATED PIPE EXPOSED TO WEATHER

A. Where piping is exposed on roof, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Provide heat tracing on piping subject to freezing.

3.11 INSULATION SHIELDS

A. Provide full size diameter hangers and shields (18 gauge minimum) for cold and hot water piping. Provide 18-inch long, noncompressible calcium silicate insulation section at insulation shields and saddles.

3.12 PIPING OVER CONCERT HALLS

A. All piping including water, waste and trap primer lines shall be wrapped with a minimum of 2” thick acoustical insulation or in accordance with Architect’s directions.

END OF SECTION

GENERAL PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Refer to Section 22 00 00.

PART 2 - PRODUCTS

2.1 GENERAL

A. Owner maintains specific products control for buildings. Shortfalls will be approved by Owner's Representative.

2.2 PLUMBING PIPING

A. Refer to Section 22 05 12 for service types.

2.3 CLEANOUTS

A. General: Locate cleanouts as shown on Drawings and as required by local code. Cleanouts same size as pipe except that greater than 4 inches will not be required. Plastic components not allowed, except unless specifically noted.

B. Types:
1. Tile Floor Cleanouts: Zurn 21406-BP-TX-VP, recessed square top for tile, heavy-duty cast iron body, bronze plug and vandalproof screws, inside caulk.
2. Carpeted Floor Cleanout: Zurn Z-1406-BP-CF-VP, carpet cleanout marker, round heavy-duty cast iron body and top, bronze plug, inside caulk, vandalproof screws.
3. Concrete Floor Cleanout (General): Zurn ZB-BP-VP round heavy-duty nickel cast iron body, bronze top, bronze plug, vandalproof screws, inside caulk.
4. Wall Cleanout: Zurn 21446-BP-VP, countersunk bronze plug, cast iron cleanout tee, stainless steel shallow cover and vandalproof screws.

C. Manufacturers: Zurn Z 1474 heavy duty cast iron cleanout housing and Zurn Z 1449.

2.4 VALVES

A. General: Refer to Section 22 05 23.

2.5 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

A. Piston-type, copper, brass or stainless steel with O-ring piston, pressure rated, tested and certified in accordance with PDI WH-201.

B. Manufacturers: PPP series "SC" system rated, Sioux Chief, or Wilkins.

2.6 VENT FLASHING SLEEVES

A. Cast iron caulking type roof coupling for cast iron stacks, cast iron threaded type roof coupling for steel stacks, and cast bronze stack flashing sleeve for copper tubing.

B. Refer to Architectural Details.

C. Do not use lead without approval by Architect and Owner's Representative.

2.7 TP-1 TRAP PRIMERS

A. Trap seal primer valve with integral automatic antisiphon protection. PPP "Prime Rite", Zurn, or Sioux Chief.

2.8 ACCESS PANELS

A. Provide flush-mounting access panels as required for service of fire dampers, cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

B. Manufacturers: Milcor, Karp, Elmdor, In-Ryko or Acudor. Provide two keys for each set of locks provided.

2.9 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814.

B. Manufacturers: Hilti, Proset, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Perform work by journeyman plumes and apprentices, no exceptions.

3.2 TESTING

A. General:
1. Provide temporary equipment for testing, including pumps, compressors, tanks, and gauges, as required. Test piping systems before insulation (if any) is installed and remove or disengage control devices before testing. Where necessary, test sections of each piping system independently, but do not use piping valves to isolate sections where test pressures exceed local valve operating pressure rating. Fill each section with water, compressed air, or nitrogen and pressurize for the indicated pressure and time.
2. Notify Architect and local Plumbing Inspector 2 days before tests.
3. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to a water pressure of a minimum of 5 PSI head. System to hold water without a water level drop greater than 1/2 pipe diameter of largest nominal pipe size within a 24-hour period. Test system in sections if minimum head cannot be maintained in each section. The 5 PSI head to be the minimum pressure at the highest joint.
4. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for a period of two hours with no loss in pressure.
5. Send test results to Architect for review and approval.

B. Testing of Pressurized Systems:
1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
2. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.

C. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at a hydrostatic pressure of 125 PSIG.

3.3 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

A. Locate shock absorbers in supply pipe in accordance with recommendations of Plumbing and Drainage Institute PDI-WH201. Determine size of absorber by fixture unit value of fixture supplied, using PDI symbols to designate sizes. Provide access panel for each shock absorber.

B. Install at each fixture, bank of fixtures, hose bibb, wall hydrant, PRV or solenoid valve.

3.4 ADJUSTING AND CLEANING

A. Piping: Clean piping exterior surfaces. Comply with Section 22 07 00, Plumbing Insulation, as applicable. Flush out water-filled or drainage piping systems with clean water.

3.5 CHLORINATION

A. Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping. Disinfection and testing shall be executed by Independent Testing Agency.

B. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 4-6 hours. After retention, drain, reflush and return system to service, AWWA C601.

C. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.

3.6 PROTECTION

A. Keep pipe openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, ductwork, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore to its original condition or replace fixtures, equipment or apparatus damaged prior to final acceptance of the work.

3.7 ACCESS PANELS

A. Install ceiling or wall access panels to provide access to concealed valves, motors, shock arrestors, and other plumbing items needing service. Provide access panels at locations required or as specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

END OF SECTION

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, materials, equipment and services necessary to furnish and install a complete plumbing system as shown on the Drawings and specified herein. The work includes, but is not necessarily limited to:
   1. Plumbing fixtures and trim, including rims for sinks and lavatories in casework or counters, chair carriers (as required), drinking fountain, drains, cleanouts, floor sinks, and related fixtures shown on the Drawings.
   2. Rough-in and final connection to equipment and fixtures, relocated or provided under other sections or under other divisions of the work.
   3. Standards and supports for equipment requiring them.
   4. Instructions and maintenance manuals for equipment furnished by this Section.

1.2 SUBMITTALS

A. Product Data in Accordance with Division 01: Manufacturer's specifications, installation and startup instructions, capacity and ratings, with selection indicated. Provide pump performance curves with selection points indicated. Provide specialties and accessories required for a complete and operable installation.

B. Shop Drawings:
   1. Assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of components and anchorages.
   2. Submit For:
      a. Fixtures, Faucets and Trim.
      b. Carriers and supports.
      c. Floor Drains.
      d. Roof, overflow roof, drains, and downspout nozzles.

C. Maintenance Data: Submit maintenance data and parts list for each item. Include "troubleshooting" maintenance guides. Include this data in maintenance manual.

1.3 PLUMBING FIXTURES

A. General: Provide factory fabricated fixtures of type, style and material indicated on the Plumbing Fixture Schedule on the Drawings. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, and as required for complete installation. Where more than one type is indicated, selection is installer's option; but, fixtures of same type must be furnished by a single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.
   1. Fixtures: Complete with fittings, supports, fastening devices, faucets, valves, traps, stops and appurtenances required.
   2. Exposed IPS Piping and Tubing: Brass, chrome plated.
   3. Escutcheons: Brass, chrome plated.
   4. Fixture Locations: As detailed on Architectural Drawings.
   5. Stops: Stops installed in each supply pipe at each fixture accessibly located with wall escutcheons.
   6. Showers: Provide with flow control device to prevent flow over 2.0 GPM.
   7. Public Lavatories: Provide with flow control device to prevent flow over 0.5 GPM.
   8. Interior Faucets except Lavatories: Provide with flow control device to prevent flow over 1.5 GPM.

1.4 DELIVERY, HANDLING AND STORAGE

A. Fixtures: Deliver plumbing fixtures individually wrapped in factory fabricated containers. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

PART 2 - PRODUCTS

2.1 CHINA FIXTURES

A. American Standard, or Kohler.

2.2 FLUSHOMETERS

A. Sloan.

2.3 FAUCET FITTINGS

A. Chicago.

2.4 WATER CLOSET SEATS

A. Olsonite 10SSCCTR heavy duty, commercial grade anti-microbial, self sustaining hinge and white color.

2.5 FLOOR DRAINS

A. Cast iron body, double drainage flange with weep holes, flashing clamp device, adjustable or insert type strainer. Comply with ANSI A112.21.1.

B. FD-1 finished area floor drain:
   1. Zurn Model: ZN-415-6-P-VPR w/Z1035, 6” square strainer.

2.6 FIXTURE TRIM

A. Traps: Provide traps on fixtures except fixtures with integral traps. Exposed traps shall be 17 gauge chromium plated cast brass tubing with escutcheon.
   1. Lavatory: McGuire 8902-C-DF

B. Supplies and Stops: Commercial grade: Chrome plated with brass stems. Stops: Loose key type. Chicago 1016-CP 3/8 inch (Lavatory) and 1017-CP 1/2 inch (Sink) Supplies shall be Chicago or McQuire. Rigid supply nipples and escutcheon plates.
   1. Barrier Free Access: Provide McGuire Pro-Wrap on P-Trap and hot and cold water supplies.

C. Manufacturer: Chicago or McGuire.

2.7 WATER CLOSESTS

A. WC-1:
   1. Fixture: Kohler K-4330, wall hung.
   2. Flush Valve: Sloan WES-111-YO, dual flush, 1.6/1.16PF.

B. Horizontal Carrier: Zurn Z1203-NR4-45-50-X or Zurn Z1203-NL445-50-X.

C. Vertical Carrier: Zurn Z1204-N-45-50-X.

D. Mounting Height: Mount all wall hung water closets at 17” floor to bowl ledge.

2.8 LAVORATORIES

A. L-1 Barrier Free:
   1. Fixture: Kohler K-2196-4, 4” centers, 3 hole punch.
   2. Faucet: Chicago 3300-ABCP, 0.5 GPM flow.
   3. Countertop depth: 21” minimum.

2.9 SHOWER UNIT

A. SH-1: Fiber Fab Model 63 H1 one piece shower enclosure with 1 inch low profile threshold, pre-sintalled L shaped stainless steel grab bar and fold down seat. Shower valve to be Powers e426-E-G-1-0-N-Y thermostatic valve with high temperature shut-off.

2.10 FIXTURE SCHEDULE

A. Provide fixtures as scheduled on the Drawings.

PART 3 - EXECUTION

3.1 FIXTURES INSTALLATION

A. General:
   1. Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and serve intended purposes.
   2. Set and connect to soil, waste, vent and water piping in neat, finished and uniform manner. Connections to be equal height, plumb and set at right angles to floor, wall or both unless otherwise required or specified.
   3. Seal fixtures mounted on floors and walls at abutting joints with approved sealant compounds as directed by Architect.

4. For ADA accessible toilets, provide with actuator at wide portion of stall.
5. Lavatories: Set mixing valves to limit outlet temperature to 110F.

B. Fixture Locations: As shown on Drawings. Center water closets and urinals between privacy partitions unless noted otherwise.

C. Stops: Stops installed in each supply pipe at each fixture accessibly located with stops of loose key type. Concealed stops to be screwdriver or loose key type with wall escutcheons.

D. Fixture Supports:
1. Support wall hung water closets, urinals and lavatories on heavy duty, full size, concealed, commercial grade carriers mounted to floor structure. Refer to Plumbing Fixture Connection Schedule on Drawings.
2. Support other fixtures mounted on stud partitions on heavy concealed wall brackets bolted to a 1/4-inch thick by 5-inch high steel plate anchored firmly to studs with bolts (or welded to metal studs). Plate to extend one stud each way beyond fixture mounting point width.

E. Flush Valves: Provide "drop-ear" ells or couplings in wall at water supply outlets to flush valves; anchor firmly to structure.

F. After fixtures are set in place and secured to walls, caulk all around between fixtures and wall with white silicone caulking compound. Dow Corning 780, General Electric Construction Sealant, or approved.

G. Set countertop lavatories and stainless steel sink rims in waterproof sealant made for application.

H. Adjust self-closing faucets to provide minimum of 10 seconds of waterflow, and maximum of 15 seconds.

I. After fixture installation is complete, cover and protect rims, fronts and exposed parts until completion of construction phase. Contractor responsible for damage to fixtures and assumes related fixture repair or replacement costs.

J. At Barrier-Free accessible drinking fountains/water coolers, set at heights required for OSSC Barrier-Free compliance. See Architectural Drawings for bi-level fixtures. Provide right/left high/low orientation to match installation. Provide apron/skirt as required.

3.2 FLOOR DRAINS

A. General: Install drains in accordance with manufacturer's written instructions and in locations indicated.

B. Coordinate with piping as necessary to interface drains with drainage piping systems.

C. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of floor drains flush with finished floor. Set floor sinks as required by local codes.

D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

E. Position drains so that they are accessible and easy to maintain.

F. Coordinate drain flashing, flanges and strainer types and depths with floor substrate and topping configuration.

G. Primers: Prime drains [which experience intermittent use]. Refer to Drawings and coordinate location with Architect. Coordinate with local AHJ for exact requirements.

3.3 ADJUSTING AND CLEANING

A. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation. Adjust water pressure at drinking fountains, faucets, shower valves and flush valves to provide proper flow stream and specified GPM. Repair leaks at faucets and stops.

3.4 EXTRA STOCK

A. General: Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner.

3.5 FIELD QUALITY CONTROL

A. Inspection:
1. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

2. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect. Remove cracked or dented units and replace with new units.

3.6 PROTECTION

A. Protect new and existing fixtures from damage. Replace damaged items with new. Workers are not to use fixtures during construction. Fixtures shall be covered with cardboard and sealed.

END OF SECTION

BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Work included in 23 00 00 applies to Division 23 work to provide materials, labor, tools, permits and incidentals to provide and make ready for Owner's use heating, ventilation, and air conditioning systems for proposed project.

B. Related Work Specified Elsewhere:
   1. Contents of Section applies to Division 23 specifications.
   2. Requirements of Section are a minimum for Division 23 Sections, unless otherwise stated in each Section, in which case that Section's requirements take precedence.

1.2 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 23:
   1. ADA Americans with Disabilities Act.
   2. AHJ Authority Having Jurisdiction.
   3. ANSI American National Standards Institute.
   4. ARI Air-Conditioning & Refrigeration Institute.
   5. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers.
   6. ASME American Society of Mechanical Engineers.
   7. ASTM American Society for Testing and Materials.
   8. ASSE American Society of Sanitary Engineering.
   9. AWWA American Water Works Association.
   10. CGA Canadian Gas Association.
   11. CISPI Cast Iron Soil Pipe Institute.
   12. CSA Canadian Standards Association.
   13. ETL Electric Testing Laboratories.
   14. FM FM Global.
   15. HI Hydraulic Institute Standards.
   16. HVAC Heating, Ventilating and Air Conditioning.
   17. MSS Manufacturers Standardization Society.
   18. NEC National Electric Code.
   19. NEMA National Electrical Manufacturers Association.
   20. NFGC National Fuel Gas Code.
   21. NFPA National Fire Protection Association.
   22. NRCA National Roofing Contractors Association.
   23. NSF National Sanitation Foundation.
   24. OMSC Oregon Mechanical Specialty Code.
   25. OESC Oregon Electrical Specialty Code.
   26. OSSC Oregon Structural Specialty Code.
   27. OSHA Occupational Safety and Health Administration.
   28. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
   29. TEMA Tubular Exchanger Manufacturers Association.
   30. TIMA Thermal Insulation Manufacturers Association.
   31. UL Underwriters Laboratories Inc.

B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

1.3 ADDITIONAL REQUIREMENTS TO DIVISION 01

A. Operation and Maintenance Documentation: Include copies of certificates of code authority acceptance, test data, parts lists, maintenance information for all equipment and devices requiring service or adjustment, balancing reports, copies of approved submittal data, equipment start-up documentation, certificates of warranties, and the like, specified elsewhere or indicated on Drawings. All O&M documentation is to be provided electronically in PDF format.

B. Shop Drawings: Provide shop drawings which include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and the like. Refer to individual Specification Sections for additional requirements for the shop drawings.

C. Close-out Documentation: Submit mechanical code authority certification of inspection.

D. Record Drawings:
1. Show changes and deviations from the Drawings. Include issued Addendum and change order items.
2. Make changes to the Drawings in a neat, clean, and legible manner.

E. Product Data:
1. Submit manufacturer's technical data, installation instructions and dimensioned drawings for products, equipment and devices installed, supplied or provided. Refer to individual specification sections for specific items required in product data submittal. Submit at one time in 3-ring binder, tabbed and referenced to match the Contract Documents.
2. Maintain an updated product submittal package to be included in the final operation and maintenance documentation.

1.4 QUALITY ASSURANCE

A. Where Contract Documents are at variance with applicable codes governing work, code and local jurisdiction requirements take precedence, and include cost necessary for code compliance or local jurisdiction compliance in bid price. Machinery and equipment to comply with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements.

B. Mechanical Drawings: Drawings are intended to be diagrammatic and are based on one manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., ducts and piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than basis of design, including but not limited to architectural, structural, electrical, fire sprinkler, and HVAC.

C. Requirements: As a minimum requirement, work in accordance with following rules and regulations and applicable laws:
1. NFPA.
2. OSHA.
3. Oregon Mechanical Specialty Code.
4. Oregon Structural Specialty Code.
5. State of Oregon and local jurisdictional requirements.

D. Permits and Inspections:
1. Unless otherwise distinctly hereinafter specified, apply and pay for necessary permits, plans check, and inspections required by public AHJ.
2. Refer to General and Supplementary Conditions for payment of water and sewer service connection fees.
3. Obtain certificates of inspection from AHJs and deliver to Owner before final acceptance.
4. Each trade to consult local building department and utility companies prior to commencement of work to ascertain existence and location of existing underground utilities. Protect existing service against damage and interruption of use, and reroute as may be necessary to accomplish new work. Include costs for materials and installation for rerouting as specified for new work in bid price.

E. Regulatory Requirements:
1. UL and CSA Compliance: Provide units which are UL, ETL, and CSA UL and CSA listed.
2. ASME Compliance: Provide units which are ASME listed when boilers which exceed 200,000 BTUH, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.

1.5 SEQUENCING AND SCHEDULING

A. For proper execution of work cooperate with other trades as needed.

B. To avoid installation conflicts, thoroughly examine complete set of Contract Documents. Resolve conflicts with Architect prior to fabrication and installation.

C. Prior to installation of equipment requiring electrical connections, examine manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that electrical characteristics indicated in Contract Documents are consistent with electrical characteristics of actual equipment being installed. When inconsistencies occur request clarification from Architect.

1.6 TEMPORARY HEATING

A. The building return-air and exhaust-air systems are not to be used for temporary heating.

B. Pressure clean coils and vacuum clean ductwork prior to occupancy.

1.7 COORDINATION DOCUMENTS

A. Prepare and submit coordinated layout drawings, prior to construction, to coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, and electrical services. Composite Drawings show services on single sheet. Key Drawings to structural column identification system, and progressively number. Prior to completion of Drawings, coordinate proposed installation with architectural and structural requirements, and other trades (including electrical, ceiling suspension, and tile systems), and provide reasonable maintenance access requirements.

B. Prepare Drawings as follows:
1. Prepare Drawings to accurate scale of 1/4 inch = 1 foot or larger on AutoCAD. Drawings are to be same size as Contract Drawings and to indicate location, size and elevation above finished floor of HVAC equipment, ductwork, and piping. Drawings to also indicate proposed ceiling grid and lighting layout as shown on electrical drawings and reflected ceiling drawings.
2. Review and revise as necessary section cuts in Contract Drawings after verification of field conditions.
3. Indicate system piping including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
4. Piping that must be graded to have right-of-way over more flexible items.
5. Drawings are to incorporate Addenda items and change orders.
6. Distribute drawings to trades and provide additional coordination as needed.

C. Advise Architect, in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Final coordination drawings with appropriate information added to be submitted as Record Drawings at completion of project.

1.8 EXISTING SOILS CONDITIONS

A. Understand existing soils conditions before submitting bid on work. No additional allowance will be granted due to lack of information for existing conditions of subsurface soils.

B. Submission of a bid will be considered acknowledgment of review/understanding of project geotechnical soils report.

PART 2 - PRODUCTS

2.1 HAZARDOUS MATERIALS

A. Do not use products containing asbestos, lead, arsenic, or any other material defined by EPA as hazardous to human or animal life.

2.2 MATERIALS

A. Base contract upon furnishing materials as specified. Materials and equipment used for construction are to be new, the latest products as listed in manufacturer's printed catalog data and are to be UL or CSA approved or acceptable by state, county, and city authorities. Equipment supplier is responsible for obtaining state, county, and city acceptance on equipment not UL approved or not listed for installation.

B. Articles and equipment of a kind to be standard product of one manufacturer.

C. Trade names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

A. Install equipment having components requiring access (i.e., drain pans, drains, fire dampers, control dampers, control operators, valves, motors, drives, and the like) so that they may be serviced, reset, replaced or recalibrated and the like, by service people with normal service tools and equipment. Notify Architect in writing if equipment or components are shown in such a position that above cannot be accomplished.

B. Install equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment, examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods and sequencing, in coordination with other trades and disciplines.

C. Earthwork: Perform excavation and backfill for installation of mechanical work.

D. Firestopping:
   1. Coordinate with Drawings location of fire rated walls, ceilings, floors and the like. When these assemblies are penetrated, seal around piping, ductwork, equipment, and the like, with approved firestopping material.
   2. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

3.2 SEISMIC CONTROL

A. Provide per Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

3.3 REVIEW BY ENGINEER

A. Notify Architect/Engineer, in writing, at following stages of construction so that Architect/Engineer may, at their option, visit site for review and construction observation:
   1. Underground piping installation prior to backfilling.
   2. Prior to covering walls.
   3. When ceiling installation is started.
   4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
   5. When ductwork installation starts.
   6. When installation starts for each different major type of equipment.
   7. When lines or ducts are to be permanently concealed by construction or insulation systems.
   8. When balancing and testing is started.

3.4 MUTILATION

A. Repair mutilation of building around pipes, ducts, and the like.

3.5 DEMOLITION

A. Scope:
   1. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas.
   2. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.

B. Unless specifically indicated on the Drawings, remove unused equipment, fittings, rough-ins, connectors, etc. Removal is to be to a point behind finished surfaces (floors, walls, ceilings, etc.).

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

B. Maintain design intent where equipment other than as shown in Contract Documents is provided. Where equipment requires piping arrangement, control diagrams, or sequencing different from that indicated in Contract Documents, provide electrical motors, wiring, controls, or other required electrical components at no additional cost to Owner.

3.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials and equipment in a manner to prevent damage and deterioration. Store in original container which identifies manufacturer's name, brand and model number. Do not store indoor equipment outdoors unless provided with a waterproof protective cover.

B. Replacement: In event of damage, immediately make repairs and replacements necessary.

3.8 DEMONSTRATION

A. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Representative and Architect that equipment furnished and installed or connected under provisions of these Specifications functions mechanically in manner required.

B. Manufacturer's Field Services: Furnish services of qualified persons for a period of not less than 80 hours, at a time approved by Owner, to instruct maintenance personnel, and demonstrate to satisfaction of Owner that entire system is operating in a satisfactory manner and complies with requirements of the contract documents. Complete instruction and demonstration prior to final job site observations.

3.9 CLEANING

A. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated by this work.

B. Vacuum clean all existing ductwork.

3.10 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions, plumb and level, firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

B. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of mechanical systems.
   2. Furnish sufficient refrigerant and dry nitrogen for pressure testing under manufacturer's supervision.
   3. Provide and install additional fan sheaves and pump impellers to obtain design capacities. Coordinate exact requirements with balancing firm.

3.11 PAINTING

A. Ferrous Metal: After completion of mechanical work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., piping, hangers, hanger rods, equipment stands, and the like, with one coat of black asphalt varnish or black enamel suitable for hot surfaces.

B. Machinery:
   1. In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
   2. See individual equipment Specifications for other painting.
   3. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

C. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.

3.12 CUTTING AND PATCHING

A. Refer to Section 01 73 29 "Cutting and Patching."

3.13 ACCEPTANCE

A. System can not be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
   1. Testing and balancing reports.
   2. Cleaning.
   3. System balancing and balancing logs.
   4. Operating and Maintenance Manuals.
   5. Training of operating personnel.
   6. Record Drawings.
   7. Guaranty certificates.
   8. Start-up and test document.
   9. Letter of conformance.

3.14 COMMISSIONING

A. Test HVAC control systems to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with these specifications and drawings. Functionally test sequences of operation.

B. See Section ”Controls” for control sequences of operation.

C. Work by Contractor:
   1. Assist the Commissioning Agent in preparing commissioning procedures by providing data pertaining to mechanical and control equipment, and installation procedures.
   2. As part of the required submittals for the contract, within 3 months of the award of the contract, submit for each piece of equipment and controls, manufacturer's startup and installation procedures as well as controls point-to-point and sequence checkout and provide in check list format.
   3. Complete all phases of work so functional mechanical and control systems can be started, tested, adjusted, and balanced.
   4. Start of commissioning procedures before system completion does not relieve mechanical equipment installer from completing mechanical systems in accordance with the Contract Documents and the construction schedule.
   5. Ensure that equipment and systems are installed and started in accordance with the Contract Documents and manufacturer's requirements and recommendations.
   6. Provide trained personnel to assist the Commissioning Agent in functional testing of systems slated for commissioning, and to correct any deficiencies indentified in accordance with 01 91 15 – HVAC Commissioning Requirements.

3.15 PRE-OCCUPANCY FLUSH

A. Operate HVAC system prior to occupancy continuously for 2 weeks with all terminal units at full design flow. Maintain minimum 60 degrees Fahrenheit in all spaces during flush.

3.16 LETTER OF CONFORMANCE

A. Provide letter and copies of extended warranties with a statement in letter that mechanical items were installed in accordance with manufacturer's recommendations. Include letter of conformance and warranties in operating and maintenance manuals.

B. Warranties to begin at date of substantial completion.

END OF SECTION

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
1. Materials, installation and testing of pipe, tubing and fittings.
2. Refer to Specification Sections for each system medium (i.e., plumbing, hydronics, gas, and the like), for pipe application.

1.2 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping products of types and sizes required.

1.3 SUBMITTALS

A. Piping Materials List: Provide a typewritten list which schedules the piping materials to be used for each system as a function of applicable nominal pipe size ranges. Arrange schedule in outline form for each specific piping system, e.g., "Chilled Water System," "Heating Water System," and the like. Include ASTM, ANSI or other numbers and other data as necessary to demonstrate compliance with requirements.

B. Test Procedure: Submit a typewritten checklist type of testing procedure indicating testing medium (i.e., water, air, nitrogen, and the like), pipe service, pipe and fitting type and classification, test pressure, pass/fail criteria and any other pertinent data.

PART 2 - PRODUCTS

2.1 PIPING - GENERAL

A. Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service, as indicated in other Division 23 Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

2.2 COPPER TUBE

A. Temper: Annealed (hard drawn).

B. Water Service: ASTM B88, Type as indicated for each service.

C. Drain, Waste, and Vent (DWV): ASTM B306.

2.3 FITTINGS FOR COPPER TUBE

A. Wrought copper/bronze solder joint fittings complying with ANSI B16.22.

B. DWV Service:
1. Cast Copper Solder Joint Drainage Fittings: ANSI B16.23.
2. Wrought Copper Solder Joint Drainage Fittings: ANSI B16.29.

2.4 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Insulating (Dielectric) Unions: Standard units recommended by manufacturer for use in the service indicated, which isolate ferrous from nonferrous piping, and prevent galvanic corrosion action. Minimum rated "flashover" voltage: 600 volts. Watts 3000 Series. Provide insulated flanges for flanged piping system connection to dissimilar metals.

B. Tin-Antimony Soldering Materials: ASTM B13.

C. Copper-Brazed: Make brazed joints for copper tubing and fittings with code approved brazing filler alloys meeting ASTM and AWS standards and listings. Filler alloys of BCuP2 classification (e.g., "Phos-O" or "Fos-Copper") may not be used to make joints between copper tubing and cast brass or bronze fittings. Filler alloys containing cadmium are not approved for use in potable water piping. Installations conform to accepted published procedures, i.e., UPC Installation Standard 3-75 and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited.

2.5 UNIONS

A. Copper Pipe Union: 200 PSI working pressure. Bronze body, solder or grooved ends. Pipes 2 inches and under use ground joint, pipes 2-1/2 inches and larger use flanged face or grooved ends.

B. Insulating Unions: 250 PSI working pressure. Pipe ends and material to match piping. Electric current below 1 percent of galvanic current. Gasket material as recommended by manufacturer. Epco or approved.

2.6 ESCUTCHEONS

A. Brass material, chrome plated finish. Size sufficient to cover pipe openings through wall, floor or ceiling. Set screw or spring to secure to pipe. Coordinate opening sizes.

2.7 ACCESS PANELS

A. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

B. Provide flush mounting access panels as required for service. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3 feet lateral clearance from sides of electric switchgear panels. Do not route piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such items.

B. Installation/Coordination:
1. General: Comply with basic requirements of Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each route with a minimum of joints and couplings, but with adequate and accessible unions or flanges for disassembly, maintenance, and replacement of valves and equipment. Reduce sizes by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance. Comply with ANSI B31.9 Code for Pressure Piping.
2. Installed piping not to interfere with maintenance of equipment, opening of doors or other moving parts nor be directly above or near any portion of electrical equipment.
3. Support piping such that connected equipment and flanges do not bear weight of piping.
4. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near the riser or, preferably, by a base fitting set on a pedestal.
5. Piping not to be suspended or supported by pumps. Apply no force to pumps by connecting pipes. After final pipe adjustments and initial operational verification of the pumps, recheck alignment of pumps and realign as required.
6. Piping systems are to be installed to drain. Provide properly sized drain valves at low points.
7. Ream pipes after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods for opening and closure.
8. Remake or replace defective, leaking or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.
9. Install piping to prevent stresses and strains to piping and hangers and supports due to expansion or contraction and building settlement. Provide proper loops, guides, offsets, anchor points, or expansion joints. Verify with anticipated settlement or shrinkage of building. Verify construction phasing of project, type of building construction products and type for coordinating installation of piping systems. Include provisions for servicing and removal of equipment without dismantling piping.

10. Piping Systems Routing Within Unconditioned Spaces, Plenums, Chases, or Cavities:
    a. Unless absolutely unavoidable, route fluid filled and (or) pressurized piping systems on the "warm" side of local building wall, roof, or ceiling thermal insulation batts, boards, or blankets as near to heated space as practical.
    b. Whenever such routing as described above is entirely impractical or impossible, provide heat tracing systems to piping, wherever necessary. Inform Architect before proceeding.
11. Pipe Penetrations:
    a. Floor Sleeves: Caulk pipes passing through floor with approved caulking compound. Provide "Link-Seal" Type S sleeve sealing system for slab on grade. Caulk/seal piping and ductwork passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
    b. Wall Sleeves: Caulk pipes passing through walls with nonshrinking caulking compound. Caulk/seal piping and ducts passing through fire-rated building assemblies with UL approved fire-rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
12. Conform with applicable codes and industry standards.
13. Install uninsulated piping so that unrestrained direct contact with the structure or other system installations is avoided. Where contact with or passage through building or structural features cannot be avoided; firmly anchor piping to, or isolated from, the structure to prevent noise transmission and occurrence of physical damage. Install piping to be insulated with adequate clearance around piping to allow for placement of full thickness insulating material.

C. Pressure Piping Routing:
1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.
2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
3. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 1/2 inch wherever furring is indicated for concealment of piping. Allow for insulation thickness, if any. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
4. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.

D. Preparation:
1. Unions:
    a. Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions wherever piping of dissimilar metals are adjoined. Install unions in manner which will prevent galvanic action and inhibit corrosion.
    b. Standard Unions: Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
2. Copper Tubing:
    a. Remove burrs from and clean outer surface of tube ends and inner surface of fittings.
    b. Copper-Soldered: Make soldered joints for copper tubing and fittings with code approved solder alloys meeting ASTM and ANSI standards and listings. Solder-paste-flux combination fillers are not approved. Installations to conform to accepted published procedures, i.e., UPC IS 375, IS 21-80 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Apply flux as recommended by manufacturer. Allstate Silver Bearing Solder 430 or other approved solder alloys which do not contain lead or cadmium.
    c. Copper-Brazed: Make brazed joints for copper tubing and fittings with code approved brazing filler alloys meeting ASTM and AWS standards and listings. Filler alloys of BCuP2 classification (e.g., "Phos-0" or "Fos-Copper") may not be used to make joints between copper tubing and cast brass or bronze fittings. Filler alloys containing cadmium are not approved for use in potable water piping. Installations to conform to accepted published procedures, i.e., UPC IS 3-75 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Remove bonnets and nonmetallic seats on valves and cool body with damp cloth while soldering or brazing. Remove excess flux from completed joints in accordance with manufacturer's instructions and code standards.

d. Pressurized Service:
   1) Unless otherwise indicated, wrought copper/bronze solder joint fittings complying with ANSI B16.22.1995.
   2) Copper Tube Unions: Standard products as recommended by manufacturer for use in the service. Rated at 150 percent design operating pressure.

3.2 FIELD QUALITY CONTROL

A. Inspection:
   1. Upon completion of installation of equipment and after units are water pressurized, test to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
   2. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove and replace with new unit. Feasibility and match to be judged by Architect. Remove cracked or dented units and replace with new units.

3.3 ADJUSTING AND CLEANING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of painting, insulation, or coatings, if any. Comply with the preparation requirements of Section 23 05 53, Identification for HVAC Piping and Equipment, and Section 23 07 00, HVAC Insulation, as applicable. Inspect each segment of each system for completion of joints, supports, and accessory items.

B. Inspection: Inspect pressurized piping in accordance with the procedures of ANSI B31.9.

3.4 PROTECTION

A. Protect piping from damage. Replace damaged items with new.

3.5 ESCUTCHEONS

A. Install on exposed pipes passing through walls or floors.

3.6 PIPE TEST

A. General:
   1. Make tests in presence of Architect or authorized representative.
   2. Make test before pipes are concealed.
   3. Apply test pressure of 125 PSI and maintain for 4 hours with no visible leaks and no appreciable drop after the test pump has been disconnected.
   4. Correct leaks in screwed fittings by remaking the joint. Cut out leaks in welded joints and reweld; caulking is not permitted.

3.7 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, fire dampers, terminal units, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

B. Where access panels are for service of fire, fire/smoke, or smoke dampers, stencil the words "Fire Damper," "Fire/Smoke Damper," or "Smoke Damper" in 1/2-inch high capital letters on the outside of the panels.

END OF SECTION

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation and testing of motors and starters.

B. Refer to Specification sections for each system medium (i.e., hydronics, gas, and the like), for motor/starter application.

1.2 QUALITY ASSURANCE

A. Motor Manufacturers:
   1. General Electric, Westinghouse, U.S. Motors, Wagner, Century/Gould, Louis-Allis, Reliance, Marathon, or approved.
   2. Standards: ANSI/IEEE 112 and NEMA MG-1.

B. Starter Manufacturers:
   1. Allen Bradley, Square D, General Electric, Siemens, Furnas, Eaton Electrical, or approved.
   2. Manufacturer is certified ISO 9002 facility 3, UL listed.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, motor efficiency, installation instructions, and dimensioned drawings for each type of motor or starter.

B. Maintenance Data: Submit maintenance data and parts list for each type. Include this data, product data, and certifications in maintenance manual.

PART 2 - PRODUCTS

2.1 ELECTRIC MOTORS

A. Motors: Energy efficient, suitable for nonoverloading operation, and capable of continuous operation at full nameplate rating. Motors 1 HP and larger must meet Energy Policy act of 1992. Motors to be high efficient type similar to Century/Gould E-plus.

B. Take NEMA standards as minimum requirements for motor design and performance. Motors suitable for load, duty, voltage, frequency, hazard and for service and location intended. Motors, unless specified otherwise, to be general purpose open dripproof type, ball bearing equipped, 40C temperature rise; and rated for continuous duty under full load. Motors to have name plate giving manufacturer's name, shop number, HP, RPM and current characteristics.

C. Motors smaller than 1/2 horsepower, 1 phase; and motors 1/2 horsepower and larger, 3 phase and voltage as indicated on Drawings. Maximum motor speed of 1750 RPM, unless otherwise noted. One phase motors to have internal thermal overload protection with automatic reset.

D. Motors for belt drive to have adjustable bases with set screw to maintain belt tension. Motor horsepowers indicated on the Equipment Schedule on Drawings are the minimum size acceptable.

E. Provide two-speed motors where indicated on schedule or in sequence.

F. Provide inverter rated motors per NEMA MG1-31 where variable frequency drives are applied or soft start starters.

2.2 STARTERS

A. Single Phase Motors:
   1. Manual across-the-line starting switch having toggle-operated switch pilot running light and built-in thermal overload device with heating element rated not more than 115 percent motor full load current indicated on name plate of motor to be protected. Surface mount starters. Provide NEMA-1 enclosure.
   2. Overload relays to be melting alloy type with a replaceable control circuit module. Thermal units to be interchangeable. Starter to be nonoperative if thermal unit is removed.
   3. Single phase motors with automatic controls. Provide motor rated relay with coils rated for control voltage.

B. Starters up to size 8 to be suitable for the addition of a minimum of three external auxiliary contacts (normally open or normally closed). Contactor, coils, and relays to perform the control functions of the associated equipment and control sequence.

2.3 DISCONNECTS

A. Provided factory-mounted non-fused disconnect switch unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install a soft start per the manufacturer's specifications with a minimum clearance of 4 inches on each side of the enclosure.

B. Include a standard wiring diagram for making the appropriate electrical connections.

3.2 START UP

A. For soft starters provide the services of a qualified technician to program, test, and start up soft starts furnished under this Specification.

END OF SECTION

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation and testing of valves, including the following:
   1. Drain valves.
   2. Ball valves.
   3. Balancing valves.
   4. Swing check valves.

B. Refer to Specification sections for each system medium (i.e., plumbing, hydronics, gas, and the like), for valve application.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of valves of types and sizes required.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of valve.

B. Maintenance Data: Submit maintenance data and parts list for each type valve. Include this data, product data, and certifications in maintenance manual.

PART 2 - PRODUCTS

2.1 VALVES - GENERAL

A. General:
   1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
   2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6 inches and smaller, and 4 inches and smaller for plug valves.
   3. End Connections: Mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Service:
   1. Water Shutoff and Isolation Valves:
      a. Pipe Sizes 2-1/2 Inches and Smaller: Ball valve.
   2. Drain Service; All Pipe Sizes: Drain valves.
   3. Check Valves: Swing check valve.

C. Manufacturers: Crane, Anvil, Jenkins, Mueller, Conbraco, Nibco, DeZurik, Stockham, Hammond, Watts, Milwaukee, Victaulic, or approved. Note: See individual sections for specialty valves (balancing valves, pressure regulators, relief valves, earthquake valves.

2.2 GLOBE VALVES

A. 2 Inches and Smaller: Class 125, bronze body, screw-in bonnet, integral seat, renewable disc, straight body, Nibco 211. Angle body, Nibco 311.

2.3 DRAIN VALVES

A. Class 125, bronze body, screw-in bonnet, rising stem, composition disc, 3/4-inch hose outlet. Threaded: Nibco 73. Solder: Nibco 72.

2.4 BALANCING VALVES

A. Bronze with a machined orifice flow restriction, multi-turn globe type valve, internal O-rings, rated working pressure of at least 240 PSIG (175 PSI iron construction, 2-1/2 inches and larger), flow setting indicating pointer and calibrated nameplate, memory stops, and pressure readout port with integral check valve on each side of the orifice. Bell & Gossett, Armstrong, Nibco, Wheatley, Tour & Anderson, or Illinois.

B. Combination check valve/balancing valve not allowed, 1/4 turn plug type allowed on 8 inches and larger pipe only.

2.5 BALL VALVES

A. 2-1/2 Inches and Smaller: 150 PSI, bronze body, full port, bronze trim, three-piece construction, TFE seats and seals. Threaded: Nibco T-595-Y. Soldered: Nibco T-560.

2.6 SWING CHECK VALVES

A. 2 Inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413.

B. Service, Teflon Disc: Nibco 480Y. Water, Gas or Oil Service, Buna-N Disc: Nibco 480.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

B. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter for each valve that must be installed with stem below horizontal plane.

C. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

D. Seats: Renewable seats, except where otherwise indicated.

E. Installation of Check Valves:
1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.

F. Balancing Valves: Install with minimum 4 pipe diameters, straight inlet and outlet pipe or per manufacturer's recommendations.

3.2 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification. Tag valves per ”Identification for HVAC Piping and Equipment.”

END OF SECTION

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Material and installation of supports, anchors and sleeves including: horizontal piping hangers and supports; vertical piping clamps; hanger rod attachments; building attachments; saddles and shields; miscellaneous metals, miscellaneous materials; anchors; equipment supports; wall and floor sleeves; and escutcheon plates.

1.2 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of supports and anchors, of types and sizes required.

B. Regulatory Requirements:
   1. Provide pipe hangers and supports whose materials, design and manufacture comply with MSS SP-58, "Pipe Hangers and Supports - Materials, Design and Manufacture," latest edition.
   2. Select and apply pipe hangers and supports complying with MSS SP-69, "Pipe Hangers and Supports - Selection and Application," latest edition.
   3. A copy of the above-referenced standards on the construction site at all times.

C. Seismic: Provide per Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Manufacturers: B-Line, Elcen Metal Products Co., F&S Control, Globe, Kindorf, Kinline, Michigan, Superstrut, Unistrut, Power-Strut. Note: See individual Sections for roof equipment support.

1.3 SUBMITTALS

A. Submit the following:
   1. Manufacturer's technical product data, including installation instructions, for each type of support, anchor and sleeve. Include UL approval drawing from manufacturer for each different pre-engineered firestop assembly.
   2. Assembly type shop drawings for each type of sleeve, indicating dimensions, weights, required clearances, and methods of assembly of components.
   3. Shop drawings for each individual roof pipe curb assembly, indicating number and location of each pipe or conduit which is to pass through the curb. Indicate pipe insulation requirements.

PART 2 - PRODUCTS

2.1 PIPING HANGERS AND SUPPORTS

A. General:
   1. Horizontal Piping Hangers and Supports-Horizontal and Vertical Piping, and Hanger Rod Attachments: Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for uninsulated copper piping systems.
   2. Building Attachments: Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.
   3. Saddles and Shields: Factory fabricated saddles or shields under piping hangers and supports for insulated piping. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12 inches in length.
   4. Roller Hangers: Adjustable roller hanger. Black steel yoke, cast iron roller.
   5. Concrete Inserts: Malleable iron body, black finish. Lateral adjustment.
   6. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.

B. Pipe Hangers Size 2 Inches and Smaller: Adjustable swivel ring hanger, UL listed. Michigan 100 or 101.

C. Riser Clamps: Steel, UL listed. Michigan 510 or 511. Copper coated; Michigan 368.

D. Plumbers Tape: Not permitted as pipe hangers or pipe straps.

E. Michigan numbers are indicated for type and quality. Comparable products manufactured by Globe, Elcen, B-Line, Kindorf, Kinline, Unistrut, Anvil, Super Strut, Tolco, PHD, Power-Strut, or approved.

2.2 WALL AND FLOOR SLEEVES

A. General:
1. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.
2. Insulating Caulking: Eagle, Pitcher Super 66 high temperature cement, or approved.
3. Fabricated Accessories:
a. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
b. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:
1) Sleeve Size 4 Inches in Diameter and Smaller: 18 gauge.
2) Sleeve Sizes 5 to 6 Inches: 16 gauge.
3) Sleeve Sizes 7 Inches and Larger: 14 gauge.
a) Fire-Rated Safing Material: Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985F and K value of 0.24 at 75F.

2.3 ANCHORS

A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer.

B. Manufacturers: Anchor-It, Hilti Hit System, Epcon System, or Power Fast System.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine the Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

B. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

3.2 INSTALLATION

A. Building Attachments: Install within concrete or on structural steel. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

B. Hangers and Supports:
1. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers. Maximum spacings: MSS SP-69. 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 support piping from other piping.
2. Support fire protection piping independently of other piping.
3. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
4. Allow controlled movement of piping systems to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
5. Piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
6. Insulated Piping: Provide protection saddles where insulation without vapor barrier is indicated. Provide protection shields on insulated piping where insulation with a vapor barrier is indicated.
7. Hanger Spacing:
a. Steel Pipe 1 Inch and Smaller: 6 feet.
b. Steel Pipe 1-1/4 Inches and Larger: 10 feet.
c. Copper Tubing 1-1/2 Inches and Smaller: 6 feet.
d. Copper Tubing 2 Inches and Larger: 10 feet.
e. 90 Degree Offsets: Within 2 feet, both sides of offset.

C. Anchors: Install at ends of principal pipe runs where indicated on Drawings. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

D. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.

E. Fabricated Pipe Sleeves:
   1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeves not to be more than 1 pipe size larger than piping or piping plus insulation size.
   2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1/4 inch above floor finish and, where floor surface drains to a floor drain, extend floor sleeve 3/4 inch above floor finish.
   3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
   4. Seal each end airtight with a resilient nonhardening sealer.

F. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
   1. Install fabricated pipe sleeve.
   2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.

G. Piping penetrations through fire-rated (1 to 3 hour) assemblies: Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.

3.3 ADJUSTING AND PAINTING

A. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.

B. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

3.4 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814.

B. Manufacturers: Hilti, Proset, or approved.

END OF SECTION

EOS

VIBRATION AND SEISMIC CONTROLS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials and installation of seismic restraint devices and related items. Provide complete vibration isolation systems in proper working order.

1.2 SEISMIC CONTROL AND RESTRAINT

A. Anchorage:
   1. Where anchorage details are not shown on Drawings, the field installation subject to approval of the project structural engineer.
   2. In other cases, retain a professional structural engineer licensed in the state in which the work will be done to provide shop drawings of seismic bracing for ductwork/equipment/water heaters. Professional engineer to design and provide wet stamped (sealed) shop drawings for equipment, ductwork, water heaters, and piping seismic bracing. Submit shop drawings and calculations along with equipment submittals.
   3. The restraints which are used to prevent disruption of the function of the piece of equipment because of the application of the horizontal force to be such that the forces are carried to the frame of the structure in such a way that the frame will not be deflected when the apparatus is attached to a mounting base and equipment pad, or to the structure in the normal way, utilizing the attachments provided. Secure equipment to withstand a force in any direction.

B. Specify the seismic bracing and anchorage of piping in Section “Hangers and Supports for HVAC Piping and Equipment.”

C. Provide earthquake bumpers to prevent excessive motion during starting and stopping of equipment and for earthquake bracing. Install bumpers after equipment is in operation to allow proper placement and alignment and ensure that bumpers are not engaged during normal system operation.

1.3 RUSTPROOFING

A. General: Design vibration isolation hardware or treat for corrosion resistance.

B. Isolators exposed to weather to have steel parts zinc electroplated, PVC coated, plus coating of neoprene or bitumastic paint. Etch aluminum components for outdoor installation and paint with industrial grade enamel.

C. Nuts, bolts and washers zinc electroplated.

D. Structural steel bases thoroughly cleaned of welding slag, primed with zinc chromate and finished with two coats of industrial enamel.

1.4 SUBMITTALS

A. Provide a complete description of products to be supplied including product data, dimensions and specifications. Provide installation instructions for each product.

B. Provide fabrication/shop drawings of steel rails, inertia bases, steel base frames, reinforcing, vibration isolator mounting attachment method, unitary straps and location of equipment attachment bolts.

C. Provide structural calculations for isolator seismic restraint for equipment including, but not limited to boilers, chillers, cooling towers, heat exchangers, roof curbs, fuel storage tanks, pumps, condensing units, AC units, exhaust fans, storage tanks, sealed by a professional structural engineer, registered in the state of Oregon.

PART 2 - PRODUCTS

2.1 METAL PARTS INSTALLED OUT-OF-DOORS

A. Cold dip galvanized, cadmium plated or neoprene coated after fabrication.

2.2 SEISMIC RESTRAINTS FOR PIPING AND DUCTWORK

A. Design restraints to meet OMSC. Provide structural engineering calculations sealed by a professional engineer registered in state of Oregon.

B. As approved by code authority, use a bracing system manufactured by Superstrut, Mason, or Pipe Shields Inc., or approved.

2.3 EQUIPMENT

A. Provide a means to prohibit excessive motion of mechanical equipment during an earthquake.

B. Provide equipment, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight.

C. Design restraints to meet OMSC. Provide structural engineering calculations sealed by a professional engineer registered in state of Oregon.

2.4 RESILIENT NONHARDENING SEALANT

A. Sealants for Acoustical Purposes: DAP acoustical sealant.

B. Manufacturers: Pecra, Tremco, USG, or approved.

PART 3 - EXECUTION – N/A

END OF SECTION

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials and installation of mechanical systems identification.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.

B. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2- by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

PART 2 - PRODUCTS

2.1 MECHANICAL IDENTIFICATION MATERIALS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Manufacturers: Allen Systems, Inc., W. H. Brady Co., Signmark Division, Industrial Safety Supply Co., Inc., Seton Name Plate Corporation, or approved.

2.2 PLASTIC PIPE MARKERS

A. Provide one of the following:
   1. Snap-on Type: Manufacturer's standard preprinted, semi-rigid snap-on, color-coded pipe markers.
   2. Pressure-Sensitive Type: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure sensitive, vinyl pipe markers.

B. Small Pipes: For external diameters less than 6 inches (including insulation, if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   1. Snap-on application of pretensioned semi-rigid plastic pipe marker.
   2. Adhesive lap joint in pipe marker overlap.
   3. Laminated or bonded application of pipe marker to pipe (or insulation).
   4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

C. Large Pipes: For external diameters of 6 inches and larger (including insulation, if any), provide either full-band or strip-type pipe markers, but not narrower than three times letter height (and of required length), fastened by one of the following methods:
   1. Laminated or bonded application of pipe marker to pipe (or insulation).
   2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inches wide; full circle at both ends of pipe marker, tape lapped 3 inches.
   3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

D. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.3 PLASTIC DUCT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded duct markers. Supply separate color codes for supply, exhaust, outside, and return air.

B. Include the Following Nomenclature:
   1. Direction of air flow.
   2. Duct service (supply, return, exhaust, outdoor air).

2.4 VALVE TAGS

A. Brass Valve Tags: Polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2 inch high, and with hole for fastener. 1-1/2-inch diameter tags, except as otherwise indicated.

B. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.

C. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include center hole to allow attachment.

2.5 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, Federal Specification L-P-387, in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch for units up to 20 sq.in. or 8 inches in length; 1/8 inch for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.6 PLASTIC EQUIPMENT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded equipment markers. Conform to the following color code:
   1. Green: Cooling equipment and components.
   2. Yellow: Heating equipment and components.

B. Nomenclature: Match terminology used on drawing schedules as closely as possible.

C. Size: Provide approximate 2-1/2- by 4-inch markers for control devices, dampers, and valves; and 4-1/2- by 6-inch markers for equipment.

2.7 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).

2.8 CEILING TILE LABELS

A. Machine-generated, adhesive-backed tape labels with black letters on clear tape.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 DUCTWORK IDENTIFICATION

A. General: Identify air supply, return, exhaust, and intake ductwork with duct markers, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork identification color).

B. Location: In each space where ductwork is exposed, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacing along exposed runs.

C. Access Doors: Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

3.3 PIPING SYSTEM IDENTIFICATION

A. Install pipe markers on each system and include arrows to show normal direction of flow.

B. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels and plenums), and exterior nonconcealed locations, in locations as follows:
   1. Near each valve and control device.
   2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
   3. Near locations where pipes pass through walls or floors/ceilings, or enter nonaccessible enclosures.
   4. At access doors and similar access points which permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced intermediately at maximum spacing of 20 feet along each piping run, except reduce spacing to 10 feet in congested areas of piping and equipment, i.e., mechanical rooms.

3.4 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system. Exclude check valves, valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.

B. Install mounted valve schedule in each mechanical room.

C. Provide color-coded round button on ceiling tile below valve location.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices: Pumps, compressors, chillers, cooling towers and similar motor driven units, electric duct heaters, terminal units, coils, fans, chillers, boilers, blowers, unitary HVAC equipment, tanks and pressure vessels, filters, water treatment systems and similar equipment.

3.6 CEILING TILE LABELS

A. Attach to ceiling grid below any equipment location requiring servicing or access (TU boxes, FSDs, etc.).

3.7 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked.

B. Cleaning: Clean face of identification devices and glass frames of valve charts.

END OF SECTION

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, equipment and labor required for testing, adjusting, and balancing work required by this Section, including air, hydronic systems, and associated equipment and apparatus. The work consists of setting speed and volume (flow) adjustments, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required.

1.2 Scope of work

A. Testing, adjusting, and Balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by a certified third party independent of the Contractor who specializes in testing, adjusting, and balancing of heating, ventilating, air-moving equipment and hydronic systems and has a minimum of 5 years experience in this specialty.

B. Make changes or replacements to the sheaves, belts, dampers, valves, etc. required for the correct balance as advised the TAB Firm, at no additional cost to the Owner.

C. The Drawings and Specifications indicate valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, provide access as requested by the TAB Firm. Correct equipment malfunction encountered during the balancing process.

D. Complete TAB services prior to Owner occupancy.

1.3 QUALIFICATIONS

A. Perform work of this Section by a firm certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).

B. Do work of this Section under the direct supervision of a person who has passed written and practical NEBB or AABC examinations for testing, adjusting, and balancing of air and hydronic systems.

C. Approved Firms: NW Engineering Service, Neudorfer, Air Balancing Specialty.

1.4 QUALITY ASSURANCE

A. Codes and Standards:
   1. NEBB Compliance: Comply with NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus; or comply with AABC's Manual MN-1, "AABC National Standards," as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
   2. Industry Standards: Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting and balancing, except as otherwise indicated.

B. Personnel: TAB personnel used on the project will be employees of the Test and Balance Agency. Perform TAB work under the direct supervision of the NEBB or AABC Certified Test and Balance Supervisor.

C. Instrumentation:
   1. List in balance report instrument description, serial number, and date of calibration.
   2. Use instruments calibrated no longer than 1 year prior to report submission.

1.5 SUBMITTALS

A. Procedures: Submit certified test reports, signed by TAB supervisor who performed TAB work.

B. Qualification Statements: Submit company’s certification documents including Contractor Certification and Supervisor certification.

C. Report Forms:
   1. Submit copies of report forms to Architect within 30 days of award of the Contract by Owner prior to commencement of testing and balancing work at the site.
   2. Provide 8-1/2- by 11-inch paper for looseleaf binding, with blanks for listing the required test ratings and for certification of report.
   3. Submit reports on forms similar in content to standard AABC or NEBB test forms.
   4. Submit final test and balance report. Include Record Drawings with terminal codes for cross-reference with the Submittal, such that terminals referenced in the Submittal are easily located on the Drawings.

5. Include identification and types of instruments used, and their most recent calibration date.
6. Submit resume data on person who is to directly supervise testing, adjusting and balancing work.

D. Maintenance Data: Include copies of balancing report and identification of instruments in maintenance manuals.

E. NEBB or AABC Certificate: At time of submittal of forms, submit NEBB or AABC certification form for review.

1.6 Warranty

A. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of any outlet, coil, or device listed in the final TAB report.

B. Warranty shall meet the requirements of the following programs:
1. AABC – National Project Performance Guarantee
2. NEBB – Conformance Certification

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. Ductwork and Housings: Use plastic plugs with retainers to patch drilled holes.

2.2 INSTRUMENTS

A. Utilize test instruments and equipment as recommended in the following:
1. NEBB's Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
2. AABC's Manual MN-1, "AABC National Standards."

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Perform TAB work with doors, closed windows, and ceilings installed, etc., to obtain simulated or project operating conditions. Do not proceed until systems scheduled for testing, adjusting and balancing are clean and free from debris, dirt and discarded building materials.

B. Verify the following:
1. Equipment is operable and normal condition.
2. Temperature control systems are installed complete and operable.
3. Final filters are clean and in place.
4. Duct systems are clean of debris.
5. Dampers are in place and open.
6. Access doors are closed.
7. Air outlets are installed and connected.
8. Hydronic Systems have been flushed, filled, and vented.
9. Correct pump rotation.
10. Proper strainer baskets are clean and in place.
11. Service and balance valves are open.
12. Any conditions affecting system operation, such as open doors, adjacent pressurized areas, and the like, are in final operating conditions prior to testing and balancing.

C. Report any defects or deficiencies noted during performance of services to Architect and Commissioning Agent. Promptly report abnormal conditions in Mechanical Systems or conditions which prevent system balance.

D. Automatic Temperature Control Systems:
1. Set and adjust automatically operated devices to achieve required sequence of operations. Coordinate with the automatic temperature control supplier. Do not proceed without his representation.
2. Verify controls for proper calibration and correct as necessary.

3.2 TEST HOLE LOCATIONS

A. Install test holes at the inlet and outlet of air handling unit fans, exhaust fans, utility fans, and the like, and elsewhere as required to facilitate traverses and to test the air systems. Plug holes when finished. Install test holes in air handlers to obtain test data for each component.

3.3 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, outside, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets. Log shows each successive test.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

G. Adjust fans to deliver within 5 percent of specified flow. Adjust air outlets and inlets to within 10 percent of specified flow. Adjust to obtain balance with minimum fan speed possible.

H. Adjust fan for variable air volume systems with terminal units at 50 percent cooling airflow, opening terminal units at end of controlling duct run to achieve fan flow specified. Report final duct static pressure setpoint and supply fan and exhaust/return fan VFD speeds and frequencies.

I. Adjust outside air to fans as scheduled. Measure outside air for variable air volume fans at full flow. Adjust belt driven fan speeds to obtain necessary flow with variable frequency drive at 60 Hertz.

J. Adjust relief exhaust fans on variable air volume systems to maintain a positive building static pressure of 0.05 inch w.c. Verify and document calibration of building static pressure sensors.

3.4 EXHAUST FAN TESTING

A. Location

B. Manufacturer.

C. Model.

D. Airflow, specified and actual.

E. Total external static pressure, specified and actual.

F. Inlet pressure.

G. Discharge pressure.

H. Fan RPM.

3.5 ELECTRIC MOTORS TESTING

A. Manufacturer.

B. HP/BHP.

C. Phase, voltage, amperage; nameplate, actual, no load. Record voltage and amperage on all phases of 3 phase motors.

D. RPM.

E. Service factor.

F. Starter size, rating, heater elements.

3.6 V-BELT DRIVES TESTING

A. Identification/location.

B. Required driven RPM.

C. Driven sheave, diameter and RPM.

D. Belt, size and quantity.

E. Motor sheave, diameter and RPM.

3.7 DUCT TRAVERSE TESTING

A. System zone/branch.
B. Duct size.
C. Area.
D. Design velocity.
E. Design airflow.
F. Test velocity.
G. Test airflow.
H. Duct static pressure.
I. Air temperature.
J. Air correction factor.

3.8 AIR DISTRIBUTION TESTING

A. Air terminal number.
B. Room number/location.
C. Terminal type.
D. Terminal size.
E. Design velocity.
F. Design airflow.
G. Test (final) velocity.
H. Test (final) airflow.
I. Percent of design airflow.

3.9 TERMINAL UNIT TESTING

A. Manufacturer.
B. Type (i.e., constant, variable, single, dual duct).
C. Identification/number.
D. Location.
E. Model.
F. Size.
G. Minimum static pressure.
H. Minimum design airflow.
I. Maximum design airflow.
J. Maximum actual airflow.
K. Inlet static pressure.
L. Inlet and outlet temperature with heating valve open.
M. Coil water pressure drop, inlet and outlet temperatures and flowrate.

3.10 DUCT PRESSURE SENSOR (VAV SYSTEM) TESTING

A. Location.
B. Static pressure with fan at block load airflow.

3.11 WATER SYSTEM PROCEDURES

A. Adjust water systems to provide required or design quantities. Use calibrated orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on pressure drop across various heat transfer elements in the system.

B. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

C. Effect system balance with automatic control valves fully open to heat transfer elements.

D. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shutoff valves for balancing unless indexed for balance point.

E. Balance each heating water riser to the flow specified for associated finned tube heaters.

F. Adjust differential pressure on variable flow systems to minimum value that produces design flows to equipment.

3.12 PUMP DATA TESTING

A. Identification/number.

B. Manufacturer.

C. Size/model.

D. Impeller.

E. Service.

F. Design flow rate, pressure drop, BHP.

G. Actual flow rate, pressure drop, BHP.

H. Shutoff, discharge, and suction pressures.

I. Differential pressure setpoint for each hydronic system.

J. Parallel and single pump operation.

3.13 HEATING COIL TESTING

A. Identification/number.

B. Location.

C. Service.

D. Manufacturer.

E. Airflow, design and actual.

F. Water flow, design and actual.

G. Water pressure drop, design and actual.

H. Entering water temperature, design and actual.

I. Leaving water temperature, design and actual.

J. Entering air temperature, design and actual.

K. Leaving air temperature, design and actual.

L. Air pressure drop, design and actual.

3.14 CHILLED BEAM

A. Identification/number.

B. Location.

C. Manufacturer.

D. Airflow, design and actual.

E. Entering air DB temperature, design and actual.

F. Leaving air DB temperature, design and actual.

G. Water flow, design and actual.

H. Water pressure drop, design and actual.

I. Entering water temperature, design and actual.

J. Leaving water temperature, design and actual.

3.15 FINNED TUBE

A. Identification/number.

B. Location.

C. Manufacturer.

D. Water flow, design and actual.

E. Water pressure drop, design and actual.

F. Entering water temperature, design and actual.

G. Leaving water temperature, design and actual.

3.16 ADJUSTING

A. Recorded data represents actually measured or observed conditions. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops. Adjust air systems to deliver specified volumes with lowest possible fan speed.

3.17 DOMESTIC WATER

A. Adjust domestic water recirculation system to ensure hot water circulation in mains.

END OF SECTION

HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Piping and Equipment Insulation: Materials and installation of insulation, jackets and accessories for the following applications:
   1. Chilled water piping systems.
   2. Heating water piping systems.
   3. Condensate piping systems.
   4. Refrigeration pipe.

B. Ductwork Insulation: Materials and installation of duct insulation including the following applications:
   1. Air conditioning and heating ductwork.

1.2 QUALITY ASSURANCE

A. Qualification of Workers: Use proficient journeyman insulators and supervisors in the execution of this portion of the work to ensure proper and adequate installation of insulation throughout. A firm with at least 5 years successful installation experience on projects with installations similar to that required for this project.

B. Compliance with Specifications:
   1. Whenever required during progress of the work, furnish proof acceptable to the Owner that items installed are equal to or exceed requirements specified for this work.
   2. In the event such proof is not available, or is not acceptable to the Owner, the Owner may require the Contractor to remove the item or items and replace with material meeting the specified requirements and to repair damage caused in the removal and replacement, at no additional cost to the Owner.
   3. Install per manufacturer's written instructions.
   4. As a minimum, comply with appropriate state energy code or other applicable codes.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of insulation, jacket, glue, paint, fitting cover, and accessory. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each piping, equipment and duct system requiring insulation.

1.4 PRODUCT HANDLING

A. Protection: Use means necessary to protect insulation materials before, during and after installation.

B. Replacements: In the event of damage, immediately make repairs and replacements necessary.

1.5 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a flame spread of 25, fuel contributed of 50 and smoke developed of 50 as tested by ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with the requirements of UL "Pipe and Equipment Coverings R5583 400 8.15."

C. Test duct insulation in accordance with ASTM E84 and bear the UL label.

1.6 LINING MATERIALS

A. Materials to be mold-, humidity-, and erosion-resistant surface that meets the requirements of UL 181.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Piping: Armacell LLC Armaflex, Certainteed, Imcoa, Johns Manville, Knauf, Nomaco, Owens-Corning, PPG, or approved.

B. Ductwork: Armacell LLC Armaflex, Certainteed, Johns Manville, Knauf, Owens-Corning, PPG, or approved.

2.2 TYPE 1, FIBERGLASS PIPE INSULATION

A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
1. Thermal Conductivity Value: 0.27 at 75F.
2. Maximum Service Temperature: 850F.
3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples or vapor barrier mastic as needed.

2.3 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.
1. Thermal Conductivity Value: 0.27 at 75F.
2. Maximum Service Temperature of 220F.
3. Maximum Flame Spread: 25.
4. Maximum Smoke Developed: 50 (1 inch thick and below).
5. Connection: Waterproof vapor retarder adhesive as needed.
6. UV Protection: UV outdoor protective coating as needed.

B. Glue Used in Cementing Rubber Insulation: Contact adhesive specifically manufactured for cementing flexible elastomeric foam. Armacell LLC Armaflex 520 adhesive, or Halstead.

C. Paint Used to Cover Rubber Insulation: Nonhardening high elasticity type, specifically manufactured as a protective covering of flexible elastomeric foam insulation for the prevention of degradation due to exposure to sunlight and weather. Armacell LLC Armaflex, or Halstead.

2.4 TYPE 7, FLEXIBLE FIBERGLASS BLANKET

A. ASTM C553, Type 1, Class B-2; flexible blanket.

B. 'K' Value: 0.27 at 75F installed.

C. Density: 0.75 lb./cu.ft.

D. Vapor Barrier Jacket: FSK aluminum foil reinforced with fiberglass yarn and laminated to fire resistant Kraft, secured with UL listed pressure sensitive tape or outward clinched expanded staples and vapor barrier mastic as needed.

2.5 TYPE 8, DUCT LINER

A. ASTM C1071; flexible blanket.

B. 'K' Value: ASTM C518, 0.25 at 75F.

C. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."

D. Maximum Velocity on Mat or Coated Air Side: 5,000 FPM

E. Adhesive: UL listed waterproof type.

F. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

G. Mold-, Humidity-, and Erosion-Resistant Surfaces: UL 181.

2.6 JACKETING

A. PVC Plastic Fitting Covers: Schuller Zeston 2000. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

B. Canvas Jacket: UL listed fabric, 6 oz/sq.yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

C. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.

2.7 ACCESSORIES

A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e.,

adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments.

2.8 PIPE FITTING INSULATION COVERS

A. PVC preformed molded insulation covers. Zeston, or approved.

2.9 DUCT INSULATION ACCESSORIES

A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

2.10 DUCT INSULATION COMPOUNDS

A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Do not apply insulation until pressure testing of the ducts has been completed. Do not apply insulation until the duct has been inspected.

B. Examine areas and conditions under which duct insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to be insulated.

3.3 INSTALLATION

A. Insulation: Continuous through walls, floors, partitions except where noted otherwise.

B. Piping and Equipment:
1. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that the insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until the piping has been leak tested and has passed such tests. Do not insulate chiller manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
2. Cover insulation on pipes above ground, outside of buildings, with aluminum jacketing. Position seam on bottom of pipe.

C. Ductwork:
1. Install insulation in conformance with the manufacturer's recommendations to completely cover the duct.
2. Butt insulation joints firmly together and install jackets and tapes smoothly and securely.
3. Apply duct insulation continuously through sleeves and prepared openings, except as otherwise specified. Apply vapor barrier materials to form a complete unbroken vapor seal over the insulation.
4. Coat staples and seals with vapor barrier coating.
5. Cover breaks in the jacket material with patches of the same material as the vapor barrier. Extend the patches not less than 2 inches beyond the break or penetration in all directions and secure with adhesive and staples. Seal staples and joints with brush coat of vapor barrier coating.
6. Fill jacket penetrations, i.e., hangers, thermometers and damper operating rods, and other voids in the insulation with vapor barrier coating. Seal the penetration with a brush coat of vapor barrier coating.
7. Seal and flash insulation terminations and pin punctures with a reinforced vapor barrier coating.
8. Continue insulation at fire dampers up to and including those portions of the fire damper frame which are visible at the outside of the rated fire barrier. Insulation terminations at fire dampers in accordance with the above.
9. Do not conceal duct access doors with insulation. Install insulation terminations at access doors in accordance with the above.

10. Duct Liners: Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with a continuous 100 percent coat of adhesive. For widths over 20 inches, additionally secure the liner with mechanical fasteners 15 inches on center. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation overlap sides. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty. Cut studs off near washers. Do not use small pieces. If insulation is installed without horizontal, longitudinal, and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.
11. Duct Wrap: Cover supply air ducts except ducts internally lined. Wrap tightly with circumferential joints butted and longitudinal joints overlapped minimum of 2 inches. Adhere insulation with 4-inch strips of insulating bending adhesive at 8 inches on center. On ducts over 24 inches wide, additionally secure insulation with suitable mechanical fasteners at 18 inches on center. Circumferential and longitudinal joints stapled with flare staples 6 inches on center and covered with 3-inch-wide, foil reinforced tape.

3.4 PROTECTION AND REPLACEMENT

A. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

3.5 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate the vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

3.6 PIPING SURFACES TO BE INSULATED

Item to be Insulated:	System Insulation Type:	Pipe Size:	Insulation Thickness:
Aboveground heating.	1	Runouts up to 2" All others	1" 1-1/2"
Aboveground chilled water piping.	1	=<1" 1-1/4" to 2" >2"	0.5" 0.75" 1"
Chilled, heating water valves.	2	N/A	1"
Refrigeration suction piping.	2	all	1"
Condensate drain piping.	2	all	1/2"

Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

3.7 DUCTWORK SURFACES TO BE INSULATED

Item to be Insulated:	System Insulation Type:	Duct Size:	Insulation Thickness:
Supply ductwork (where duct is not specified to be lined.	7, 8	all	1-1/2"

Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

3.8 FLEXIBLE ELASTOMERIC TUBING

A. Slip insulation over piping or if piping is already installed, it should be slit and snapped over the piping. Joints and butt ends must be adhered with 520 adhesive.

3.9 INSULATION SHIELDS

A. Provide full size diameter hangers and shields (18 gauge minimum) for cold piping. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 1 1/4 inches and larger.

END OF SECTION

CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. General – Extend existing control system to serve remodeled areas.

1.2 RELATED SECTIONS

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

B. The following sections constitute related work:
   1. Section 01 00 00 - General and Special Requirements
   2. Section 01 33 00 - Submittal Requirements
   3. Section 23 36 00 – Terminal Units
   4. Section 23 82 00 – Terminal Heat Transfer Equipment
   5. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

1.3 APPROVED CONTROL SYSTEM CONTRACTORS

A. Approved Control System Contractor and Manufacturer:
   1. Siemens Building Technologies APOGEE System to match existing campus BAS.

1.4 SUBMITTALS

A. Product Submittal Requirements. Meet requirements of Section 01 33 00 on Shop Drawings, Product Data, and Samples. Provide six copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2004 (or newer) compatible files on optical disk or hard copies on 11” x 17” prints of each drawing. When manufacturer’s specification sheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means.

B. Project Record Documents: Submit three copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
   1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD 2004 (or newer) compatible files on optical media and as 11” x 17” prints.
   2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3: “Control System Demonstration and Acceptance.”
   3. Operation and Maintenance (O & M) Manual.
      a. As-built versions of the submittal product data.
      b. Operator’s Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
      c. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
      d. Documentation of all programs created using custom programming language, including set points, tuning parameters, and object database.
      e. Graphic files, programs, and database on magnetic or optical media.
      f. List of recommended spare parts with part numbers and suppliers.
      g. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
      h. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
      i. Licenses, guarantees, and warranty documents for equipment and systems.

1.5 WARRANTY

A. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Failures on control systems that include all computer equipment, transmission equipment and all sensors and control devices during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner’s warranty service request.

B. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with the above-mentioned items.

C. Contractor shall not be required to warrant reused devices, except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

D. Contractor shall not be required to warrant systems, equipment and devices or software if the damages and/or failures were caused by lack of training, unauthorized use, negligence or deliberate action of other parties, or job site conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All products used in this project installation shall be new and currently manufactured. Match the base building control system and devices. Spare parts are to be available for at least five years after completion of this contract.

PART 3 - EXECUTION

3.1 TRAINING

A. Provide 4 hours of site specific training for Owner's operating personnel.

3.2 SEQUENCE OF OPERATION

A. General Requirements
   1. All heating setpoints are to be 68F and cooling setpoints 77F unless noted otherwise. Unoccupied heating setpoints are 55º F. Allow 4F of user adjustability in dance and music performance classrooms.
   2. Provide daily automatic recalibration or resetting of all floating control valve and damper actuators.

B. Radiant Floor Heating System:
   1. Modulate the heating water control valve and cycle the pump to maintain the room temperature heating setpoint. The radiant floor system shall act as the first stage of heat before activating the TU heating.
   2. Monitor the radiant loop HWS and HWR temperatures.
   3. Monitor the floor temperature. Initiate alarm at workstation if the floor temperature exceeds 80F.
   4. Heating Water Pump (HWP-3 and 4):
      a. Operate lead pump from workstation H-O-A graphic and time-of-day schedule.
      b. Pump is to run on a call for heating at any radiant zone during the occupied mode or morning warm-up.

C. Chilled Beams (CB):
   1. When space is occupied, cycle the chilled water control valve and TU airflow to maintain space cooling setpoint of 77F (adjustable). Interlock with lighting occupancy sensor.
   2. The chilled water control valve shall act as the first stage of cooling when the chillers are off (chiller well water heat-exchanger is being utilized) or when the outdoor dewpoint temperature is higher than the AHU-1 discharge-air dewpoint setpoint. Airflow from the terminal unit will act as the second stage. At all other times, use the room terminal units as the first stage of cooling before opening the chilled beam control valves.

D. Baseboard Finned-tube heaters (FT):
   1. When space is occupied, modulate heating water control valve to maintain space heating temperature setpoint of 68F (adjustable). Interlock with lighting occupancy sensor.

E. Cooling Only Terminal Units (TU) – without CO2 Control or Humidistat:
   1. When space is occupied, modulate damper between zero and maximum CFM to maintain space cooling setpoint of 77F (adjustable). Interlock operation with lighting occupancy sensor.
   2. For rooms with chilled beams, refer to chilled beam sequences.

F. Cooling Only Terminal Units (TU) – with CO2 Control:
   1. When space is occupied, modulate damper between zero and maximum CFM to maintain space cooling setpoint of 77F and maximum CO2 setpoint of 1000 ppm (adjustable). Interlock operation with lighting occupancy sensor.
   2. For rooms with chilled beams, refer to chilled beam sequences.

G. Window Switches:
   1. Provide a position switch on each operable window to signal when the window is open.
   2. Shut off airflow, chilled water flow and heating water flow to any room that has an open window.
   3. Alarm the workstation when any window is left open during unoccupied hours.

H. Fire/Smoke Dampers (FSD):
   1. Fire/smoke dampers close upon building fire alarm system sensing smoke in fire zone, and shut down fan units serving fire alarm zone.
   2. Wiring of FSD control from FACP by Division 28. Coordinate with Division 28.
   3. Monitor end-switch status through DDC system, indicating when damper is fully open and when fully closed.

I. Terminal unit with hot water reheat (TU) with C02 and Humidistat:
   1. When the space is occupied, modulate damper between zero and CB MAX cfm to maintain space cooling setpoint of 77F and maximum CO2 setpoint of 1000 ppm (adjustable). Modulate hotwater control valve to maintain 68F heating setpoint (adjustable). Interlock operation with lighting occupancy sensor.
   2. On a call for additional dehumidification, open auxiliary 2-position motorized damper and modulate TU flow to MAX cfm.
   3. For rooms with chilled beams, refer to chilled beam sequences.

J. Transformer Vault
   1. Add the following sequences to the control of EF-5:
      a. If the space temperature exceeds setpoint by 10º F, send alarm to facilities workstation.
      b. If the temperature exceeds 130º F, send signal to shut down the building shunt trip breaker. Coordinate with DN 26.

END OF SECTION

HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation, and testing of:
   1. Pipes and pipe fittings for chilled water, condenser water, heating water, and drain.
   2. Valves.
   3. Hydronics specialties, including the following:
      a. Manual air vent valves.
      b. Automatic air vent valves.
      c. Gauges.
      d. Instrument probe fittings.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of components of types and sizes required.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe, pipe fitting, valve, hydronic specialty, chemical, and component.

B. Submit Piping Schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

C. Maintenance Data: Submit maintenance data and parts list for all components. Include this data, product data, and certifications in maintenance manual.

D. Certificates of Compliance: Submit letters of certification stating that the piping as submitted per the Piping Schedule is in compliance with the standards of compliance as specified.

1.4 PRODUCT HANDLING

A. Provide factory applied end caps on each length of pipe and tube. Maintain end caps through shipping, storage, and handling as required to prevent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Store components inside and protected from weather.

C. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, weatherproof wrapping.

D. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packing with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. General: Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards. All piping in a given size range of same type.

B. Service:
   1. Chilled Water (Above Grade):
      a. Pipe Sizes 2 Inches and Smaller: Copper tubing, Type K or L, with soldered fittings (95/5 solder).
   2. Heating Water (Above Grade):
      a. Pipe Sizes 2 Inches and Smaller: Copper tubing, Type K or L, with soldered fittings (95/5 solder).
   3. Drain Pipe:
      a. Steel, galvanized, Schedule 40, threaded fittings.
      b. Copper tubing, M, soldered fittings (95/5 solder).

C. Copper Tube - Temper: Provide Type "K" hard drawn temper unless otherwise directed.

2.2 VALVES

A. General: Provide end connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.

2.3 MANUAL AIR VENT VALVES

A. Manufacturers: Armstrong, Bell & Gossett, Hoffman, Spirax Sarco, or approved.

B. Operated manually with screwdriver or thumbscrew, 1/8-inch NPS or 1/4-inch NPS connection as required.

2.4 AUTOMATIC AIR VENT VALVES

A. Manufacturers: Taco Hy-Vent, Bell & Gossett, Hoffman, or approved for branch lines. Hoffman 78 or approved at air separators, mains, in mechanical rooms.

B. Float type with pressure rating equal to or greater than the system in which it is installed.

2.5 STRAINERS

A. Manufacturers: Mueller, Armstrong, Keckley, Hoffman, Hayward, Wheatley, Victaulic, or approved.

B. General: Full line size strainers with ends matching connecting piping materials, machined screen seats, gasketed cap, blow off outlet, minimum 2-1/2 to 1 open area ratio, and Type 304 stainless steel screens with 1/16-inch diameter holes.

C. Y-Strainers:
1. Copper Pipe Installations: Mueller 352-1/2.
2. Steel Pipe Installations: Mueller 11.

2.6 THERMOMETERS

A. Manufacturers: Ashcroft, Trerice, Weiss, Palmer, Marshaltown, Weksler, or approved.

B. 3-inch diameter bimetal dial thermometer, stainless steel case, white dial, black numbers, 4-inch stainless steel stem, brass separable socket. Back or bottom connections as required.

Service	Range
Heating Water	50 to 300F
Chilled Water	0 to 120F
Condenser Water	50 to 150F

2.7 THERMOMETER WELLS

A. Manufacturers: Same as thermometers.

B. Brass or stainless steel, pressure rated to match piping system design pressure. Provide extensions for insulated piping of length required to extend above insulation used at each location. Provide cap nut with chain fastened permanently to thermometer well.

2.8 PRESSURE GAUGES

A. Manufacturers: Amtek/U.S. Gauge, Ashcroft, Palmer, Marshaltown Instruments, Trerice, Weiss, Weksler, or approved.

B. Type: General use, 1 percent accuracy, ANSI B40.1, Grade A, phosphor bronze bourdon type, bottom connection.

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

D. Connector: Brass with 1/4-inch male NPT.

E. Scale: White coated aluminum, with permanently etched markings.

F. Range:
1. Pump Suctions: 30-inch Hg - 60 PSI.
2. Water: 0 - 100 PSI.

2.9 INSTRUMENT PROBE FITTINGS

A. Manufacturers: Pete's Plug, or approved.

B. Brass or stainless steel body and cap, high pressure rated, valve material neoprene, Nordal or Viton to suit temperature range, 1/4 inch or 1/2-inch NPT tailpiece.

2.10 PIPE ANCHORS

A. Manufacturers: Flexonics, Mason Industries, Amber-Bush, Metraflex, or approved.

B. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

PART 3 - EXECUTION

3.1 HYDRONICS SPECIALTIES INSTALLATION

A. Manual Vent Valves: Install on each hydronic terminal at highest point, and on each hydronic piping drop in direction of flow for mains, branches, and runouts, and elsewhere as indicated. Provide manual vents of 1/8 inch in size in pipes through 2 inches in diameter, and vents of 1/4 inch size in pipes 2-1/2 inches and larger.

B. Installation of Temperature Gauges:
   1. Install in vertical upright position, tilted so as to be easily read at floor.
   2. Glass Thermometers: Install at the following locations, and elsewhere as indicated:
      a. At inlet and outlet of each chiller, boiler or heat exchanger.
      b. At inlet and outlet of each hydronic coil.
      c. At inlet and outlet of each cooling tower.
   3. Thermometer Wells: Install in piping in vertical upright position. Fill well with oil or graphite, secure cap.

C. Installation of Pressure Gauges:
   1. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
   2. Locations: Install in the following locations, and elsewhere as indicated:
      a. At each pump inlet and outlet.
      b. At inlet and discharge of each pressure reducing valve.
      c. At make up water service outlets.
      d. Provide Pete's Plug at inlet and outlet of each hydronic coil.

D. Expansion Joints: Provide where required to allow pipe expansion due to thermal stresses. Provide locations per manufacturer's recommendations. Provide a pipe guide on each side of each expansion joint, located per manufacturer's recommendations. Provide guides in addition to all other pipe supports and hangers. Do not use guides in lieu of supports or hangers required per Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.

3.2 AIR VENTS

A. Automatic: Furnish and install automatic air vents at all high points of the water systems and as otherwise required. Vents: 3/4 inch with 1/2-inch IPS drain piping to the nearest floor drain or other approved location. Provide a gate valve and union ahead of all automatic air vents.

B. Manual Vents (Where no Floor Drain or other Acceptable Location Exists): Provide 10-inch length of 1/4-inch copper tube with 180 degree bend down to discharge into hand-held bucket.

3.3 GAUGE ADJUSTING AND CLEANING

A. Adjust faces of meters and gauges to proper angle for best visibility.

B. Clean windows of meters and gauges and factory finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

3.4 PIPE TEST

A. General:
   1. Make all tests in presence of Architect or authorized representative.
   2. Make test before pipes are concealed.
   3. Fill system and remove air from system at least 24 hours before test begins.
   4. Correct leaks in screwed fittings by remaking the joint. Cut out and reweld leaks in welded joints; caulking is not permitted.

B. Water Piping: Apply test pressure 125 PSI and maintain for 1 hour with no visible leaks and no appreciable drops after the test pump has been disconnected.

3.5 PIPE ANCHORS

A. Furnish and install pipe anchors where shown or required to prevent pipe movement. If fabricated, construct anchors of steel plate, 3/4-inch minimum thickness, securely welded to pipe with two steel plates, stiffeners and bolted to structure.

END OF SECTION

HEATING WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation, and testing of heating water system.

1.2 QUALITY ASSURANCE

A. Qualifications: Firms regularly engaged in manufacture of heating water system components.

1.3 SUBMITTALS

A. Provide Shop Drawings or Product Data for:
   1. Hot water specialties.
   2. Finned pipe.
   3. Hot water coils.

PART 2 - PRODUCTS

2.1 HOT WATER HEATING COILS

A. General: Provide as shown on the Drawings and as described in the Schedule hot water heating coils of the plate fin extended surface type.

B. Construction:
   1. 1/2-inch OD copper tubes with aluminum fins mechanically bonded to the tubes, 5/8-inch OD male sweat fittings. Coils are leak tested at 350 PSIG minimum air pressure, suitable for working pressures up to 250 PSIG with air vents.
   2. Headers: Nonferrous seamless copper outside the airstream and provided with tobin bronze brazed steel male pipe connections.
   3. Make copper to copper joints with high temperature brazing material (use no pressure bonding).
   4. Casings: Minimum 16 gauge galvanized steel with double formed face and stacking flanges on the side plates and with flanges on tube sheets having extruded tube holes. Furnish reinforcing rods so that the unsupported length is not over 60 inches.
   5. Coil to be completely encased in minimum 16 gauge galvanized steel cabinet with no coil headers past outside dimension of casing.

C. Arrangement: Coils, except one row, counterflow construction, with connections left or right hand as specified on the Drawings. The use of internal restrictive devices to obtain turbulent flow will not be accepted.

D. Manufacturers: USA Coil, Trane, or approved.

2.2 FINNED TUBE RADIATOR

A. General: Furnish and install where shown on the Drawings heating water finned tube assemblies. Provide I-B-R approved ratings as required. Sterling, Style-S, or approved.

B. Copper Aluminum Elements: Manufacture copper aluminum heating elements of seamless copper tube permanently bonded to aluminum fins by a mechanical process.

C. Heating Element Hangers: Hangers for heating elements of the ball bearing cradle type or (rod) type die-formed, providing for lengthwise movement of element during expansion and contraction as well as aligning element to prevent contact with bracket, wall or enclosure. Provide vertical adjustment also.

D. Pipe Hangers: Provide hanger for dry pipe lines of the roller bearing type assuring noiseless operation of these pipe lines during expansion and contraction.

E. Match existing enclosure dimensions, style and color.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install control valves and devices in piping system as required per Section 23 09 00, Controls.

B. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing all doors and passageways. Check each piece of equipment in the system for defects, verifying that all items function properly and that all adjustments have been made.

C. Install piping per Section ”Hydronic Piping.”

3.2 EXPANSION AND CONTRACTION

A. Provide for expansion of heating water lines with suitable anchors and expansion bends made up with pipe fittings.

3.3 CLEANING

A. Prior to acceptance, thoroughly clean exposed portions of the heating, remove all shipping labels and traces of foreign substance.

END OF SECTION

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation and testing of pumps for HVAC applications.

1.2 QUALITY ASSURANCE

A. Qualifications: Firms regularly engaged in manufacture of pumps with characteristics, sizes and capacities required.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, installation and start-up instructions, and performance curves with selection points indicated.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Operations and Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory, including troubleshooting maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual.

PART 2 - PRODUCTS

2.1 PUMPS, GENERAL

A. Provide factory tested pumps, cleaned and painted with enamel prior to shipment. Provide pumps of same type by same manufacturer.

2.2 IN-LINE PUMPS

A. General: Oil-lubricated, 125 PSI working pressure, 225F continuous water temperature. Cast iron body, steel shaft, ground and polished, integral thrust collar; two horizontal sleeve bearings designed to circulate oil; mechanical seal with carbon seal face rotating against ceramic seat; nonoverloading motor at any point on pump curve, open, dripproof, sleeve bearings, rubber mounted construction, built-in thermal overload protection; self-aligning flexible coupling (spring couplings not allowed). Manufacturers: Bell & Gossett, Armstrong, Weil, Amtrol, Taco, Paco, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Provide access space around pumps for service as recommended by manufacturer.
   2. Align flexible connectors for minimum initial strain.

B. Adjusting and Cleaning:
   1. Check alignment and, where necessary, realign shafts or motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
   2. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
   3. Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Materials, installation and testing of HVAC ductwork and accessories, including the following:
   1. Heating and air conditioning supply and exhaust systems.
   2. Ductwork hangers.
   3. Plenums.

1.2 QUALITY ASSURANCE

A. Unless otherwise noted, where the Specification refers to SMACNA in reference to sheet metal or flexible ductwork, this refers to HVAC Duct Construction Standards, Metal and Flexible, latest edition, as published by SMACNA.

B. Unless otherwise noted, where the Specification refers to TIMA in reference to fiberglass ductwork, this refers to Fibrous Glass Duct Construction Standards, latest edition, as published by TIMA.

C. Provide duct systems per OMSC, latest edition, and all referenced standards.

D. Have available at the project field office a copy of the referenced standards.

1.3 SUBMITTALS

A. Provide shop drawings for duct materials.

B. Submit duct pressure testing reports. Provide individual reports for each AHU duct system.

1.4 AIR DISTRIBUTION DUCT SYSTEM

A. General: All ductwork, including collars, register boxes, fire dampers, exhaust fans, ventilation louvers, roof vents and screens, as well as all dampers and any other miscellaneous items not specifically mentioned but necessary for a complete installation. Apply the latest standards of SMACNA with respect to sheet-metal gauge and general construction for round and rectangular ducts.

PART 2 - PRODUCTS

2.1 GALVANIZED SHEET-METAL DUCTWORK

A. General: IMC Duct Construction Standards, latest edition, or latest edition of ASHRAE Guide Table. 1-1/2 ounce galvanizing per square foot, both sides.

2.2 FLEXIBLE DUCTS

A. General: Comply with OMSC, latest edition, Class 0 or Class 1.

B. Standard factory fabricated product, construct an inner wall of impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix. Cover the assembly with fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier. UL 181 listed Class 1 flexible air duct material. Overall thermal transmission no more than 0.25 (BTU/in)/(hr/sq.ft./deg. F) at 75F differential, per ASTM C335. Vapor transmission value no more than 0.10 perm, per ASTM E96. Rated for a minimum of 4-inch w.g. positive pressure and 1-inch w.g. negative pressure.

C. Air friction correction factor of 1.3 maximum at 1000 FPM. Working air velocity of at least 2000 FPM. Flame spread rating no more than 25. Smoke development rating no more than 50 as tested per ASTM E84. Must have cataloged data on insertion loss characteristics, minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter and 500 Hz.

D. Manufacturers: Norflex, Clevaflex, Genflex, Atco, Flexmaster, Thermaflex, or approved.

2.3 FACTORY FABRICATED METAL ROUND AND FLAT OVAL DUCTWORK

A. General: Provide per OMSC Duct Construction Standards, latest edition, and ASTM A527 Class 0. Round sheet metal, spiral lock seam type. Fittings: Same construction as the duct. Tap in fittings not allowed. Duct sealer: Specifically formulated for sealing field joints for round spiral lock-seam duct systems.

2.4 SHEET-METAL DUCT SEALER

A. Hardcast "Duct-Seal 321" or United McGill. Indoor/outdoor, low VOC (<80 grams/liter), water based with fiber reinforcement.

2.5 PREFABRICATED DUCT JOINTS

A. Manufactured flanged traverse rectangular and round duct joints.

B. Manufacturers: Ductmate, Mez, Ward Duct Connectors, Lockformer TDC, or approved.

2.6 METAL ROUND AND FLAT OVAL SPIRAL SOUND-ATTENUATING DUCTWORK

A. General: Factory fabricated doublewall, internally insulated, acoustical attenuation. Provide perforated inner liner where noted to accomplish acoustical attenuation, and 1-inch fiberglass insulation between the walls of the duct, with thermal conductivity K factor of 0.27 (BTU/in)/(hr/sq.ft./deg. F) at 75F maximum. Provide solid inner wall where noted.

B. Provide duct systems with acoustical attenuation properties equal to or greater than those for duct type K27-P by United Sheet Metal. Fittings: Factory fabricated with slip joint construction of the same construction as the duct. Provide 45 degree lateral wye takeoffs unless otherwise indicated.

C. Manufacturers: United Sheet Metal Type K-27-P, Semco, Rolock, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout with all trades, and make alterations to the ductwork routing and layout as required to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, such alterations shall not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or run as shown on the Contract Drawings. Such determination shall be by Architect. In the event Architect determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the Owner.

B. Install ductwork in the location and manner shown and detailed. Review deviations required by job conditions with Architect prior to any fabrication. Provide fittings construction per SMACNA.

C. Connect duct assemblies such as ductwork, plenums, etc., and operating machines or mechanisms such as fans, air conditioners, etc., with flexible connections per Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Fabricate radius elbows with centerline radius not less than 1-1/2 duct diameters.

E. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.

F. Install single thickness turning vanes in square throat rectangular elbows and in tees. Provide 3/4-inch trailing edge on turning vanes, turned slightly past parallel to the duct.

G. Duct sizes indicated are free inside dimensions including where internal lining is shown.

H. Provide galvanized sheet-metal duct material for all ducts unless otherwise indicated or specified.

I. Provide temporary closures of open ducts during construction to prevent dust and debris from entering the system.

J. Flexible Duct:
1. Install flexible duct with bend radius equal to 1.5 times the diameter. Minimum length 2 feet. Maximum length 5 feet, unless noted otherwise.
2. Provide round neck grilles/diffusers or square-to-round transitions. No flex duct connections directly to square neck allowed.
3. Flex duct allowed only for vertical drops to diffusers. Maximum offset angle from vertical: 30 degrees.
4. Approved for use on supply ducts only; not allowed for return or exhaust.
5. Flex duct allowed in concealed spaces above lay-in ceilings only.

K. Fabricate ductwork and all sheet metal work of prime grade, lock forming quality steel in accordance with the current issues of SMACNA standards, and installed in strict conformance with SMACNA standards.

L. Submit shop drawings for approval for all ductwork. All ductwork to be sheet metal unless specifically authorized as other material. Provide aluminum exhaust duct within 15-feet of showers.

M. Construct ductwork upstream of VAV boxes for 3-inch pressure class; downstream duct 1-inch pressure class. All other duct 2-inch pressure class.

N. Round spiral duct and fittings or where required due to available clearances, use flat oval ductwork and fittings upstream of terminal units manufactured by United Sheet Metal, Rolok or approved in accordance with ASTM A527.

O. Seal all joints and seams in supply, exhaust, and return air ductwork and plenums.

P. Fabricate ductwork and plenums with a smooth inside surface and support and brace to prevent sagging and vibration at any time. Provide galvanized steel angles for reinforcing and bracing.

Q. Joints:
   1. Carefully cut and trim all joints and seams in fabricated ducts and fitting to form a closed joint with no portion of the duct or fitting protruding into the air stream.
   2. Seal all joints in sheet-metal ducts in concealed locations (such as enclosed ceiling spaces) with Hardcast joint sealant system applied in accordance with manufacturer's recommendations, or use Ductmate-type joints.
   3. Seal all joints in sheet-metal ducts in exposed locations with sealant system applied in accordance with manufacturer's recommendations. Wipe off excess sealer on duct to give a clean finish, or use Ductmate-type joints.
   4. To connect sheet-metal ductwork to fiberglass ductboard, use Hardcast only.
   5. Standard gray duct tape not allowed.

R. All fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.

S. Crimp flat duct surfaces diagonally or beaded regardless of size, unless acoustically lined.

T. Fabricate all duct size transitions with a slope of not more than 1 foot to 5 feet where possible, but in no case more than 1 foot in 3 feet.

U. Fabricate duct turns with the inside (smallest) radius at least equal to the duct width. Where necessary, square elbows may be used, with maximum available inside radius and with fixed single thickness curved vanes, with trailing edge extended 3/4 inch.

V. Provide flexible connectors at connections to all equipment, in ducts crossing building expansion joints and may be used at connections of dissimilar metals. Flexible Connections: Minimum 16 ounce airtight "Ventglass" noncombustible fabric with fire retardant neoprene coating on outside, fastened with bolted galvanized steel bands. Maintain a minimum 1-inch space between the connecting surfaces.

W. Duct Hangers and Supports:
   1. Hang rectangular sheet-metal ducts with a cross sectional area of less than 7 sq.ft. with galvanized strips of No. 16 USS gauge steel 1 inch wide, and all larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at 8 feet on center, as detailed.
   2. Anchor all ducts securely in such a manner as to prevent transmission of vibration to structure. Do not support ducts from other ducts or piping.
   3. For round sheet-metal ducts, provide duct support in accordance with SMACNA Guidelines. Verify type of building construction.
   4. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.
   5. Do not install duct stiffeners on interior (air side) of unlined ductwork; install on exterior only or on interior of ductwork with duct liner.
   6. Seismic Restraint: Brace all ductwork against lateral movement as detailed in document "Seismic Restraint Manual Guidelines for Mechanical Systems" as published by SMACNA.

X. Hang ducts from beams, joists or supplementary structural members provided by Contractor. Do not hang ductwork from joist bridging or from other ducts.

Y. Although not necessarily indicated on the Drawings, provide turning vanes at all mitered elbows, opposed blade balancing dampers with locking quadrants at branch ducts, volume extractors and any other applicable devices necessary for minimum duct resistance and proper system air balancing. Sufficiently stiffen all dampers to prevent noise or vibration and in no case be lighter than 20 gauge steel. Provide with accessibly located adjuster, manufactured by Young Regulator Co., Parker Kalon Corporation, or approved.

Z. Construct all exterior ductwork or ductwork which is otherwise exposed to weather watertight.

AA. Increase the size of all sheet-metal ducts as required to accommodate insulation lining.

BB. Locate access doors in ductwork as required for service of fire dampers, automatic dampers and other items requiring maintenance or inspection.

CC. Paint inside surface of all bare ductwork which is visible through face of grilles with flat black paint for all ceilings 12 feet and lower.

3.2 MOUNTING FOR SIDEWALL GRILLES AND REGISTERS

A. All mounting heights indicated on Drawings from finish floor to lower edge of grille or register. Exception: If note on Drawings states for example "Down 6 inches," this indicates measurement from ceiling to top edge of grille or register.

B. Install all sidewall return air grilles for "sight-tight" visibility at eye level (position blades to obscure visibility from floor level).

3.3 GRILLE AND EXPOSED DUCT CLEANING

A. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out all accumulation of particles from grilles and diffusers prior to acceptance.

B. Clean exterior surface of all ducts exposed to public view of chalk, pencil and pen marks, labels, sizing tags, dirt, oil dust, etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured condition ready for paint. Seams are to be neatly caulked.

C. All exposed duct and grilles shall remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

D. Refer to 23 00 00.

END OF SECTION

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation, and testing of HVAC duct accessories such as volume dampers, splitter dampers, adjustable deflectors, duct access doors, backdraft dampers, fire dampers, spin-in fittings.

1.2 QUALITY ASSURANCE

A. Provide fire dampers in conformance with the requirements of Fire Damper and Heat Stop Guide for Air Handling Systems, as published by SMACNA.

1.3 SUBMITTALS

A. Submit manufacturer's catalog data and fabrication/installation drawings for each factory fabricated duct accessory.

PART 2 - PRODUCTS

2.1 DAMPERS

A. Volume Dampers (VD):
   1. Construct of galvanized sheets not lighter than 18 gauge, reinforced to prevent vibration, equipped at both ends with brass bearing mounts and of sufficient length to provide a complete shutoff of the duct.
   2. Provide each damper with an adjustment and locking quadrant device manufactured by Young Regulator Co., No. 403 operator for accessible locations, or No. 315 for nonaccessible locations. Ventlock, or approved. Provide operating rod and attaching devices as required for No. 315 operator. Provide Young Regulator No. 443 or 443B raised platform for insulated duct.

B. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturers: Same as grilles and diffusers. Provide Young Regulator 443 or 443B raised platform for insulated duct.

2.2 FIRE/SMOKE DAMPER

A. Manufacturers: Air Balance, Inc., Cesco, Pottorff, Dowco, Greenheck, Krueger, Nailor Industries, Prefco, Price Co., Ruskin, or approved.

B. Cesco Fire Barrier Model FSD2 motorized fire/smoke damper with motor. 165K electro-galvanized steel with a 120VAC motor for motorized operation. Standard UL 212F fusible link. Provide smoke detector at each damper per code. Dynamic type. The fire dampers to be U.S. standard for 1-1/2 hour listing (unless noted otherwise). Motors to be UL listed. Provide the thermal protection via the fusible link. Damper to be normally closed. Minimum leakage Class II damper. Provide with automatic reset. 250F temperature rating. Damper to fail closed when power is interrupted to actuator (unless noted otherwise). Provide Belimo actuator with internal end-switches. In round or flat-oval medium-pressure supply ducts and return/exhaust mains, collar adapters are not allowed; and airfoil blades are required.

2.3 DUCT ACCESS DOORS

A. Gasketed, hinged or removable, rated for operating pressure. Ductmate "Sandwich" for rectangular ductwork or "Metu" for round ductwork, or approved.

PART 3 - EXECUTION

3.1 VOLUME DAMPERS

A. Provide in main duct branches where shown. Provide in branch ducts serving air inlets and outlets.

B. Locate dampers as close to trunk or main branch as possible.

3.2 FIRE/SMOKE DAMPERS AND SMOKE DAMPERS

A. Install dampers per manufacturer's instructions.

3.3 DUCT ACCESS DOORS

A. Install where shown and required for access or maintenance. Provide on the reset side of all fire dampers and adjacent to duct mounted automatic dampers. Install per manufacturer's recommendations. Provide colored ceiling pin below damper to identify its location.

B. Where access doors are for service of fire or smoke dampers, stencil the words "Fire Damper" or "Smoke Damper" in 1/2-inch high capital letters on the outside of the door.

END OF SECTION

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation and testing for variable air volume terminal units, including the following:
   1. Central Air Terminals:
      a. Shutoff.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880-98, Air Terminals, and bear ARI certification seal.
   2. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A, Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

A. Product Data: Manufacturer's technical product data, including performance data for each size and type of air terminal furnished.

B. Schedule: Showing drawing designations, room locations, number furnished, model number, size, and accessories furnished.

C. Shop Drawings: Manufacturer's assembly type shop drawings, indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

D. Sound Levels:
   1. Radiated and discharge sound power levels at octave bands 2 to 7 minimum, full range of rated inlet static pressure for each terminal size and required airflow; per ARI 880, shall not exceed.

For areas where a continuous mineral board ceiling is located below the terminal units

	Frequency (Hz)					
	125	250	500	1000	2000	4000
Classrooms & Studios	61	58	52	48	45	43
Offices	65	62	57	53	50	48
Other	69	67	62	58	55	53

For areas where the terminal unit is exposed to the room or a ceiling cloud with open edges is used

	Frequency (Hz)					
	125	250	500	1000	2000	4000
Classrooms & Studios	56	51	44	38	34	32
Offices	60	55	49	43	39	37
Other	64	60	54	48	44	42

E. Selection: Do not select units outside the range of manufacturer's cataloged data for capacity scheduled. Units to be selected and provided with a maximum inlet velocity of 2000 FPM.

PART 2 - PRODUCTS

2.1 TERMINAL UNITS

A. General: Furnish and install shutoff-type variable air volume units as herein specified.

B. Casing:
1. Factory assembled, manufactured of corrosion protected welded steel and fabricated to withstand the pressures encountered. 22 gauge minimum casing.
2. Maximum Unit Height: 18 inches.
3. Inlet: Round or oval to match standard duct sizes.
4. Casing acoustically and thermally insulated with 1-1/2 lbs./cu.ft. density. Insulation UL listed and approved for UL 181. The insulation to meet NFPA 90A requirements. Thickness: 1/2 inch minimum. Construct units with solid inner liner over insulation.

C. Air Modulation Device: Accomplish air volume control at the unit inlet by a normally open air valve or heavy duty damper. Modulate from full airflow to scheduled minimum air flow as indicated. Device capable of tight shutoff. Maximum leakage rate across the air throttling device: 3 percent of design air flow at 4-inch static pressure, 3-inch differential. Actuator compatible with linkage.

D. Flow Sensor: Provide an integral flow ring sensor or other averaging type calibration device along with unit mounted calibration chart to ensure accuracy of airflow measurement of plus or minus 5 percent under all types of inlet conditions. Single point sensing tap will not be acceptable. Flow maximums and minimums as shown on Drawings.

E. Hot Water Reheat Coil (Where applicable): Provide terminal units with hot water reheat coil where specified, performance as shown on Drawings. High temperature drop coil. 5/8-inch OD seamless copper tubes mechanically expanded to aluminum fins. 150 PSIG working pressure. Sweat connections.

F. Controls: Supplied by control manufacturer, factory mounted by terminal unit manufacturer; direct digital control. Coordinate with Contractor.

G. Manufacturers: Trane, Titus, Krueger, Price, Environmental Technology, Carnes, Enviro-Tech, Tempmaster, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install air terminals in accordance with manufacturer's installation instructions.

B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.

C. Duct Connections: Connect ductwork to air terminals as indicated.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals and duct connection to air terminals are leaktight. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

END OF SECTION

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation, and testing of HVAC outlets and inlets.

1.2 QUALITY ASSURANCE

A. Components: Tested, rated and certified per Air Diffusion Council procedures.

1.3 SUBMITTALS

A. Manufacturer's catalog data on each of the following:
   1. Type of register, diffuser, grille, frame, louver, and dampers.
   2. Schedule of air outlets and inlets indicating drawing designation, model number and accessories furnished.

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS, DIFFUSERS

A. Subject to compliance with requirements, provide products of one of the following.

B. Provide 1-, 2-, 3-, or 4-way deflection as indicated.

C. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturers: Same as grilles and diffusers.

D. Coordinate mounting frames with construction types per finish schedule.

E. Performance: Provide components that have velocity, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current standard literature, which are plus or minus 10 percent of the components as listed in the Diffuser, Register and Grille Schedule, or as specified herein.

F. Manufacturers: Anemostat, Carnes, Price Co, Titus.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install grilles, registers, and diffusers per manufacturer's instructions. Locate and size openings through finished surfaces to provide complete coverage of rough openings by integral device flanges or auxiliary frames.

B. Paint exterior of devices per color selected by Architect.

C. Coordinate duct connections with device final dimensions. Provide square to round adapters where required for connection to round ducts.

D. Adjust the throws of air outlets to eliminate drafts.

END OF SECTION

TERMINAL HEAT TRANSFER EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Submit for:
   1. Chilled beams.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. UL Compliance: Provide electrical components for terminal unit which have been listed and labeled by UL.
   2. ARI Compliance: Provide water coil capacities certified by ARI 440-98, Room Fan-Coils.

PART 2 - PRODUCTS

2.1 CHILLED BEAMS

A. General: Provide chilled beams as scheduled and indicated on drawings.

B. Tubes: Seamless copper tube expanded into fin collars for a permanent mechanical bond. Tubes fabricated from 0.025 inch seamless tube stock. Bends constructed of 0.035 inch wall thickness wrought copper. Corrugated aluminum fins minimum 0.012 inch thick. Pipe connections to be configured as required for the specific field conditions. Coil leake tested as 350 PSIG air pressure.

C. Housing: G-90 galvanized steel housing with intermediate supporting members and fasteners required to support coil assembly. Provide an oval primary air inlet connection at the end or side of the unit in the sizes as show on the drawings. Locate each inlet based on the specific field conditions determined by the Contractor.

D. Grilles: Linear slots constructed of extruded aluminum running along the sides of the unit and a return air grille constructed of perforated steel. The return air grille shall be hinged to allow it to swing-down providing access to the coil by one person without removal of the grille. When closed, the return air grille shall be secured to the unit casing with fasteners.

E. Nozzles: Provide the number and size of nozzles required to provide the specified primary airflow specified for each unit at the inlet static pressure and noise levels specified, without drafts when installed at the height and spacing indicated on the drawings. The nozzle plate shall be painted with a flat black finish.

F. Finish: Provide a powder coat baked-on enamel finish on all exposed surfaces. Paint color shall be white**,** except at Rooms 115S and 327 where paint color shall be black.

G. Capacity: As scheduled on drawings.

H. Manufacturers: Trox, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's recommendations.

B. Chilled Beams: Install where shown and as detailed. Make watertight connections to piping system. Mount to architectural supports as detailed on drawings.

END OF SECTION

HYDRONIC FLOOR HEATING SYSTEM

PART 1 - - GENERAL

PART 2 - - PRODUCTS

2.1 CROSS-LINKED POLYETHYLENE TUBING, FITTINGS AND ACCESSORIES

A. Warmboard panels:
   1. Tung-and-groove plywood panels with reflective covering and factory grooves to accept PEX tubing.
   2. Provide all accessories required for a complete installation.

B. Tubing:
   1. Cross-linked polyethylene (PEX) tubing shall comply with the requirements of ASTM F876 and F877, and the cross-linking method must be Type 'A' (hot) method.
   2. PEX tubing shall have a minimum working pressure of not less than 160 psi for water at 73.4F, 100 psi for water at 180F and 80 psi for water at 200F determined in accordance with Plastic Pipe Institute Technical Report TR-3/92, and listed in Plastic Pipe Institute Technical Report TR-4/95.

C. Fittings:
   1. Fittings: Brass.
   2. Reinforcement Rings: Manufactured using the "Engel Method" to ensure that the viscoelastic stress regenerative properties are sufficient to produce a pressure tight seal.
   3. Fitting Insert: Of such dimension in that the tubing must be expanded in order to facilitate insertion of the fitting into the tube.
   4. Accomplish the expansion of the tubing and ring by an expansion tool designed expressly for that purpose.
   5. Fittings shall comply with the requirements of ASTM F877.

D. Manifolds: Provide premanufactured copper manifolds of the same manufacturer as the piping.

E. Stubout Ells and Stubout Brackets: Provide premanufactured Type “L” copper stubout ells and copper stubout brackets.

F. Manufacturers: Warmboard system using Uponor or approved tubing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Warmboard panels:
   1. Mount panels to plywood subflooring provided by others using adhesive and fasteners in accordance with the manufacturer’s written instructions.
   2. Coordinate all requirements with the flooring contractor. Refer to Architectural details.

B. Cross-Linked Polyethylene Tubing and Fittings:
   1. Tubing Installation through walls, overhead or underfloor:
      a. Install in accordance with manufacturer’s written instructions.
      b. Allow tubing slack of 1/8 to 3/16 inch per lineal foot to accommodate thermal expansion. Do not pull tubing tight during installation.
      c. Do not rigidly anchor tubing.
      d. Protect tubing passing through hollow masonry walls or metal studs with sleeves or grommets.
      e. Protect tubing from nail or screw damage with suitable steel plate protectors.
      f. For below flooring installation , follow the warmboard manufacturer’s written instructions.
   2. Tubing Supports:
      a. Use plastic pipe supports or supports designed for use with plastic tubing.
      b. Place horizontal support every 32 inches for 3/8-, 1/2-, 3/4- and 1-inch tubing.
      c. Provide vertical support at every floor with a mid-story guide placed between floors.
   3. Joints and Connections:
      a. Square cut tubing ends, free of burrs or debris, before connection is made.
      b. Make fittings and connections in compliance with manufacturer's recommendations.
      c. Make transition joints with manufacturer approved fittings only.
   4. Fire Wall, Floor or Ceiling Penetrations:
      a. Firestopping system shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 in a configuration that is representative of field conditions.

b. Use firestop material compatible with tubing as specified herein.

5. Fixture Outlet Rough-In: Provide Type “L” copper tube stubout ells and copper stubout brackets.
6. Inspection and Testing: No visible signs of leakage, cracks, gouges or excess debris after completion of any section of the installation.

END OF SECTION

MAINTENANCE TESTING OF 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. Section 260128 - Thermography.

1.2 DESCRIPTION

A. Test and provide written certification on company letterhead that the entire electrical installation complies with contract documents, code and proper system operation. Perform acceptance tests in accordance with manufacturer's recommendations, NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-2003.

B. The following testing shall be performed by an independent testing company. All other testing may be completed by the Contractor or an independent testing company:
   1. Transformers - Dry Type over 600 volt

1.3 EQUIPMENT AND DEVICE TESTS

A. Perform all equipment and device testing after installation and prior to substantial completion or owner occupancy, allowing enough time for corrective action of all deficiencies.

B. Review manufacturer's installation instruction and confirm that equipment is installed in accordance with manufacturer's instructions.

C. Prior to performing tests confirm that the equipment is clean and free of construction debris and dust.

D. Phase Relationship Tests: Check connections to all new and existing equipment for proper phase relationship. During such check, disconnect all devices which could be damaged by the application of voltage or reversed phase sequence.

E. Test the open/close or energize/deenergize operation of each switch, circuit breaker, contactor and other item of electrical control with the systems fully energized and operating. Each shall be tested three times. Test report shall include a list of equipment tested and the signed initials of the electricians performing the test on a device by device basis.

1.4 SUBMITTALS

A. General
   1. Provide submittal information in accordance with Division 1 - General Requirements, Section 260500 - Common Work Results For Electrical and requirements described in this section.

B. Test Report
   1. The testing firm shall maintain a written record of all tests and shall assemble and certify a final test report indicating all equipment tested and the results found for each. Any system, material, or workmanship which is found to have abnormal operation, shall be specifically identified.

C. Quality Assurance
   1. The testing firm shall submit proof of company qualifications and personnel qualifications. Include resumes of recent experience (within the last three years) for the firm, engineers and technicians that will be assigned to the project. Include references with current phone numbers in the resume.
   2. Test Equipment: Provide a complete list of test equipment utilized in all of the testing. Include manufacturer, model number, current calibration date, next calibration date and age of equipment.

D. Closeout
   1. Operational and Maintenance Manuals
      a. All approved submittal information
      b. Full test report in the OANDM Manual
      c. Completed form for each item of equipment tested
   2. One electronic version of the test report on CD and in the latest version of Microsoft Word.
   3. Schedule of recommended testing frequency for all equipment tested under this contract
   4. Testing company test stamps or stickers on all tested equipment. Indicate testing company name, testing date and expiration date.

1.5 TRANSFORMERS - OVER 600 VOLT.

A. Visual and Mechanical Inspection

1. Inspect for physical damage, proper installation, anchorage and grounding.
2. Clean all bushing and insulator surfaces.

B. Electrical Tests
1. Perform insulation resistance tests winding-to-winding and winding-to-ground.
2. Transformer Taps: Measure secondary voltages. Forward a list to engineer including service switchboard voltmeter reading at the time of the test for evaluation.

1.6 RECEPTACLES

A. Receptacle Polarity Test: Test every receptacle installed or reconnected under this contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest. Submit statement of completed testing signed by the electrician that performed the test.

B. Ground-Fault Receptacle Circuit Interrupter Tests: Test each receptacle or branch circuit breaker having ground-fault circuit protection to assure that the ground-fault circuit interrupter will not operate when subjected to a ground-fault current of less than 4 milliamperes and will operate when subjected to a ground-fault current exceeding 6 milliamperes. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. "TEST" button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shutoff power with 7/1000 of an ampere within 1/40th of a second and retest.

PART 2 - PRODUCTS

2.1 TESTING COMPANY

A. Retain the services of an independent testing company that is qualified to test electrical equipment.

B. Testing company shall prepare test reports on the systems they test.

C. Testing company shall be an independent company, separate from the contractor, sub contractors, suppliers and others involved with the project.

D. Approved companies: Advanced Electrical Testing, Inc. (AET), Cutler-Hammer Engineering Services and Systems Division (CH-ESS), Electrical Reliability Services, Apparatus Service and Engineering Technology, Inc. (ASET), Siemens Westinghouse Technical Services.

2.2 TEST EQUIPMENT

A. The Contractor shall provide all apparatus and material required for testing. The Contractor shall use installation tools and test equipment which are designed for the specific task and shall use this equipment per the manufacturer's instructions. All test equipment shall have current calibration certification by a third party calibration laboratory, and shall have a signed and dated calibration sticker affixed to the device. Calibration shall be traceable to the National Bureau of Standards and be less than 6 months since last calibration. Defective test equipment and installation tools shall not be used. Installation tools such as torque wrenches shall be calibration certified.

PART 3 - EXECUTION

3.1 PROJECT DOCUMENTS

A. Deliver applicable project documents to testing company two weeks prior to testing. As a minimum include:

Division 26 Specification
Electrical Floor Plans showing equipment to be tested.
Electrical One Line Diagrams
Submittals of Manufacturers Data and Shop Drawings including engineers review letter of all systems to be tested.
Coordination Study

3.2 SCHEDULE

A. Perform all testing after installation and before energizing. All primary systems shall pass tests prior to placing in service. Notify Architect 10 working days prior to performance of any test.

3.3 TEST REPORTS

A. The Contractor shall prepare test reports including description of project, description of equipment tested, description of test, test results, conclusions and recommendations, retesting results and list of test equipment used and calibration date.

B. One copy of each test report shall be delivered directly to the electrical engineer and Owner within 7 calendar days of the test.

C. Insert a copy of each test report in the operation and maintenance manuals.

3.4 RETESTING

A. Any fault in material or in any part of the installation revealed by these tests shall be investigated, replaced or repaired by the Contractor and the same test repeated at Contractor's expense until no fault appears.

3.5 LABELS

A. Upon completion of the tests a label shall be attached to all serviced devices. These labels shall indicate date serviced and the testing company.

3.6 OBSERVATIONS BY ENGINEER

A. Contractor shall remove and replace covers of electrical equipment, open manholes and remove/replace ceiling tiles to permit engineer to observe equipment and wiring provided. Furnish ladder and flashlight.

3.7 TROUBLESHOOTING

A. If a system or device provided under this contract does not operate per manufacturers specifications contractor shall provide qualified men with tools and test equipment to find and repair problem at contractor's expense.

END OF SECTION

THERMOGRAPHY

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 specification section describes requirements for infrared inspections of electrical equipment and reports. Purpose of testing is to improve electrical system safety, efficiency and reliability by identifying electrical problems such as overloaded circuits, faulty connections, improper terminations, overheating contacts and over heated mechanical bearings prior to deterioration and catastrophic failure.

1.3 REFERENCES

A. All inspections and field tests shall be in accordance with the latest edition of the following codes, standards, and specifications as applicable to the work:
   1. Institute of Electrical and Electronic Engineers (IEEE)
      a. ANSI/IEEE C2, National Electrical Safety Code
      b. ANSI/IEEE C37, Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses
      c. IEEE Std. 48, Standard Test Procedures and Requirements for High-Voltage AC Cable Terminations 2.5kV through 276kV
      d. ANSI/IEEE Std. 450, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations
   2. InterNational Electrical Testing Association (NETA)
      a. NETA MTS Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems
   3. National Electrical Manufacturer's Association (NEMA)
      a. NEMA AB4, Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications
   4. National Fire Protection Association (NFPA)
      a. ANSI/NFPA 70B, Recommended Practice for Electric Equipment Maintenance
      b. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces

B. Comply with Occupational Safety and Health Administration (OSHA) work safety standards and guidelines

C. Comply with applicable state and local codes and ordinances.

1.4 SUBMITTALS

A. General
   1. Provide submittal information in accordance with Division 1 - General Requirements, Section 260500 - Common Work Results For Electrical and requirements described in this section.

B. Test Report
   1. The testing firm shall maintain a written record of all tests and shall assemble and certify a final test report indicating all equipment tested and the results found for each. Any system, material, or workmanship which is found to have abnormal operation, shall be specifically identified and the defect classified per the classifications described on the form. All testing and results shall be documented on the form included at the end of this specification section. The form is available electronically from the engineer. Forms must be filled out completely. Test reports missing the load current readings, are incomplete and will not be accepted. Those tests will have to be redone to assure that the equipment had sufficient load to be a valid scan providing useful information.

C. Samples
   1. Provide samples of all test and data collection forms to architect for review and approval prior to initiating thermography test work.

D. Quality Assurance
   1. The testing firm shall submit proof of company qualifications and personnel qualifications. Include resumes of recent experience (within the last three years) for the firm, engineers and technicians that will be assigned to the project. Include references with current phone numbers in the resume.

2. Test Equipment: Provide a complete list of test equipment utilized in all of the testing. Include manufacturer, model number, serial number, current calibration date, next calibration date and age of equipment.

E. Closeout
1. Operational and Maintenance Manuals
a. All approved submittal information
b. Full test report in the OandM Manual
c. Completed form for each item of equipment tested
2. One electronic version of the test report on CD and in the latest version of Microsoft Word.
3. Schedule of recommended testing frequency for all equipment tested under this contract
4. Testing company test stamps or stickers on all tested equipment. Indicate testing company name, testing date and expiration date.

1.5 QUALITY ASSURANCE

A. Qualifications Of Testing Firm
1. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
2. The testing firm shall be regularly engaged in testing and inspection (including thermography) of electrical equipment devices, installations and systems in educational facilities of similar size and complexity.
3. The testing firm shall be a Full Member company of the InterNational Electrical Testing Association.

B. Qualifications Of Lead Testing Technician and Test Technicians
1. The lead, on site, technical person shall hold a current certification in one of the following:
a. NETA (InterNational Electrical Testing Association: Certified Technician/Level III or Certified Senior Technician/Level IV
b. NICET, (National Institute for Certification in Engineering Technologies) Engineering Technician/Level III or Senior Engineering Technician/Level IV specifically in Electrical Testing Technology
2. The testing firm shall utilize technicians who are regularly employed by the firm for testing services and who have current experience doing thermography in educational facilities of similar size and complexity.
3. Technician should have been factory trained on the specific camera being utilized and should be experienced at analysis and interpretation of the infrared images.

C. Approved companies: Apparatus Service and Engineering Technology, Inc.; Electro-Test, Inc., Emerson, and Siemens-Westinghouse Technical Services.

D. Safety practices should include, but are not limited to, the following requirements:
1. Current Occupational Safety and Health regulations.
2. National Safety Council, Accident Prevention Manual for Industrial Operations.
3. Applicable state and local safety operating procedures.
4. Owner's safety practices.
5. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.
6. OSHA 29 CFR 1910.147. Control of Hazardous Energy Sources (Lockout/Tagout).

E. Pre-Testing Meeting
1. The contractor shall initiate pre-testing meeting with the testing company's lead technician, architect, engineer and Owner's representative.
2. Meeting shall take place no later than 30 days prior to any testing being initiated.
3. Contractor shall present a proposed schedule of testing for review and approval by the Owner.
4. All test forms shall be reviewed and approved by Owner's representative.
5. Testing Work Procedures Plan (WPP), preparation, processing, implementation and archiving processes shall be presented for review and approval.

1.6 SCHEDULE

A. Contractor shall schedule work in phases to meet the Owner's completion schedule. Phasing shall be arranged to accommodate load bank connections, feeder switching, equipment isolation and bypass configuring necessary to place load which exceeds 40% of rated load and is not greater than 100% of rated load, on the equipment that is being tested. It is desirable to have equipment tested under normal load as

long as that load exceeds 40% of rated load. It is absolutely mandatory that no testing expose the system operation to increased risk of accidental shut-down due to the thermography scan testing process.

B. The Contractor shall develop a complete and detailed schedule of work for submittal and approval by the Owner.

C. The Owner shall notify the testing firm when equipment becomes available for maintenance tests. Work shall be coordinated to expedite project scheduling.

D. The testing firm shall notify the Owner's representative 24 hours prior to commencement of any testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. The Contractor shall provide all apparatus and material required for testing.

B. Suitability of Test Equipment
1. All test equipment shall be in good mechanical and electrical condition.
2. Split-core current transformers and clamp-on or tong-type ammeters require careful consideration of the following in regard to accuracy:
a. Position of the conductor within the core.
b. Clean, tight fit of the core pole faces.
c. Presence of external fields.
d. Accuracy of the current transformer ratio in addition to the accuracy of the secondary meter.
3. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multimeters must be true RMS sensing. When the variable contains harmonics or dc offset and, in general, any deviation from a pure sine wave, average sensing, RMS scaled meters may be misleading.
4. Field test metering used to check power system meter calibration must have accuracy higher than that of the instrument being checked.
5. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of two percent of the scale used.
6. Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.

C. Test Instrument Calibration
1. The testing firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
3. Instruments shall be calibrated in accordance with the following frequency schedule:
Field instruments: Analog, 6 months maximum. Digital, 12 months maximum
Laboratory instruments: 12 months
Leased specialty equipment: 12 months where accuracy is guaranteed by lessor
Dated calibration labels shall be visible on all test equipment.
Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.
4. Calibrating standard shall be of higher accuracy than that of the instrument tested.

D. Infrared Equipment
1. This standard applies to the use of high resolution digital, color thermal imaging infrared radiometers that operate in the 3-5 or 8-12 micron (nanometer) band.
2. The thermal imager must have a camera sensitivity of as least one-tenth of one degree Celsius, have the capability of taking direct temperature measurements and be adjustable for emissivity at the camera and with image processing software.
3. The thermal imager must have NTSC videotaping and display date/time stamping. Also, the images that are recorded must have post-processing capabilities.

E. Reporting
1. The report shall consist of color printed text, color digital images and videotape.
2. Equipment List: Complete list of all equipment inspected and its exact plant location.

3. Thermography report shall contain images along with pertinent information including thermography report number, exact time, date, area, location, high and reference temperature in degrees Celsius, temperature rise, amperage measurements, description of problem, recommendation for corrective action, classification of the problem (using either delta-T or absolute-T criteria), and any notes or comments.
4. Summary/Recap and Repair Guide. The summary shall include general comments, notes, suggestions, and a condensed compilation of all thermography reports.
5. Three original, color copies of the thermography test report shall be delivered to the Owner's representative and one copy of the thermography test report shall be delivered directly to the electrical engineer within 7 calendar days of the on-site testing.
6. The test report shall be spiral bound (three-ring binder is acceptable only if approved in writing, by Owner's representative), include cover sheet, table of contents, tabs, reports, photos and CD ROM electronic media format copy.
7. Video Record - Provide a VHS videotape with audible track, of the entire survey. Include video of all equipment inspected and highlight the anomalies. Video tape shall include time and date stamp.

PART 3 - EXECUTION

3.1 PROJECT DOCUMENTS for TESTING COMPANY

A. Contractor shall provide the following project documents to testing company two weeks prior to testing:
   1. Project specification
   2. Electrical Floor Plans showing equipment to be tested
   3. Electrical One Line Diagrams
   4. Approved submittals for equipment to be tested, including review comments

3.2 THERMOGRAPHIC INSPECTION

A. The Owner shall supply utility electrical power to each test site. The testing firm shall provide all other power requirements necessary to perform the thermography inspection.

B. Connections and Covers: Contractor shall provide skilled electricians, familiar with this site, to operate the electrical system, make connections, connect load bank, remove covers and other work necessary to make equipment accessible for the thermography inspection. At the completion of the thermography inspection, remove all test equipment, restore all electrical systems to their normal operating configuration, and replace all covers and guards.

C. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

D. Visual and Mechanical Inspection
   1. Inspect physical, electrical, and mechanical condition for indications of overheating and arcing.
   2. Remove all necessary covers prior to thermography inspection.

E. Equipment to be scanned shall include all current-carrying devices and connections that are part of the following:
   1. Existing 12.5kV : 208Y/120 volt transformer.

F. Test Parameters
   1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
   2. Test equipment shall detect emitted radiation and convert detected radiation to visual signal.
   3. Thermography inspections should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).

G. Test Results

   Include completed test form for each piece of equipment. Include suggested actions based on temperature rise found in NETA ATS-1997, Table 10.18 (included below for reference).

TABLE 10.18
Thermography Inspection
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1ºC - 3ºC	0ºC - 10ºC	Possible deficiency; warrants investigation
4ºC - 15ºC	11ºC - 20ºC	Indicates probable deficiency; repair as time permits
-- -- --	22ºC - 40ºC	Monitor continuously until corrective measures can be accomplished
> 16ºC	> 40ºC	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT. In the absence of consensus standards for ΔT, the values in this table will provide reasonable guidelines.

3.3 RE-INSPECTION

A. All items that are reported in the thermography reports section of the inspection report shall be re-inspected after repairs have been made.

B. Original specification will apply to re-inspections.

C. Submit re-inspection reports and indicate that repairs have fixed the anomaly or indicate any remaining anomalies.

3.4 LABELS

A. Upon completion of the tests a label shall be attached to all serviced devices. These labels shall indicate date serviced and the testing company.

3.5 SECURITY

A. Contractor shall apply for and obtain all security clearances and access privileges required to comply with Owner's security procedures.

END OF SECTION

Testing Company Name
Street Address
City, State Zip Code
Phone/Fax/email

Thermography Study
For
Project Name/Project Number

Visible Light Digital Image (color)	**Infrared Digital Image (color)**

TEST INFORMATION

REPORT DATE:		PREPARED BY:	
IMAGE DATE:		IMAGE NUMBER:	
TEST EQUIPMENT DESCRIPTION:		MODEL NUMBER:	
TEST EQUIPMENT SERIAL NUMBER:		CALIBRATION DATE:	
Equipment Information			
BUILDING:		FLOOR/ROOM NUMBER:	
LOCATION: (Circle One)	Floor Level	Overhead	Concealed in Enclosure
EQUIPMENT ID #:			
DESCRIPTION:			
COMPONENT ID #:			
DESCRIPTION:			

THERMAL AND ELECTRICAL INFORMATION

THERMAL DATA (°F/°C) AND RISE				**MANUAL READINGS**			
A Phase	____/____	Reference	_____°F	A Phase	_____A	A/ B Volts	_____V
B Phase	____/____	Temperature	_____°C	B Phase	_____A	B/C Volts	_____V
C Phase	____/____	ΔT	_____°F	C Phase	_____A	A/C Volts	_____V
Neutral	____/____	or Rise	_____°C	Neutral	_____A	A/N Volts	_____V
ANOMALY TEMP(°F/°C)							

PROBLEM DESCRIPTION:

RECOMMENDATION:

ANOMALY PRIORITY

CRITICAL - IMMEDIATE ATTENTION SUGGESTED

SEVERE - PROBABLE FAILURE, PROMPT ACTION RECOMMENDED

INTERMEDIATE - MONITOR PROBLEM, SCHEDULE MAINTENANCE

MINOR - SCHEDULE ROUTINE MAINTENANCE AT NEXT OPPORTUNITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes general electrical requirements for all Division 26 work and is supplemental and in addition to the requirements of Division 1.

B. It is the intention of this Division of the Specifications and the Contract Drawings to describe and provide for the furnishing, installing, testing and placing in satisfactory and fully operational condition all equipment, materials, devices and necessary appurtenances to provide a complete electrical system. Provide all materials, appliances and apparatus not specifically mentioned herein or shown on the drawings, but which are necessary to make a complete, fully operational installation of all electrical systems shown on the contract drawings or described herein. Connect equipment and devices furnished and installed under other Divisions of this specification (or the Owner) under this Division.

C. Workmanship shall be of the best quality and competent and experienced electricians shall be employed and shall be under the supervision of a competent and experienced foreman.

D. The drawings and specifications are complimentary and what is called for (or shown) in either is required to be provided as if called for in both.

E. See Division 1 for sequence of work.

1.3 WORK IN OTHER DIVISIONS

A. See all other specifications for other work which includes but is not limited to:

Communications
Conveying Systems
Cutting and Patching
Door Hardware
Electronic Safety and Security
Equipment Wiring
Fire Protection
Mechanical Control Wiring
Mechanical Equipment
Painting, Refinishing and Finishes
Temporary Power

1.4 CODES, PERMITS, INSPECTION FEES

A. The following codes and standards are referenced in the Division 26 specifications. Perform all work and provide materials and equipment in accordance with the latest referenced codes and standards of the following organizations:

1. American National Standards Institute (ANSI)
2. National Electrical Manufacturer's Association (NEMA)
3. National Fire Protection Association (NFPA)
4. Underwriter's Laboratories (UL)

B. Install the electrical systems based on the following:

NFPA 70	National Electrical Code as adopted and amended by the Local Jurisdiction.
IBC	International Building Code as adopted and amended by the Local Jurisdiction.

C. The referenced codes establish a minimum level of requirements. Where provision of the various codes conflict with each other, the more stringent provision shall govern. If any conflict occurs between referenced codes and this specification, the codes are to govern. Compliance with code requirements shall not be construed as relieving the Contractor from complying with any requirements of the drawings or specifications which may be in excess of requirements of the governing codes and rules and not contrary to same.

D. Obtain and pay for all licenses, permits and inspections required by laws, ordinances and rules governing work specified herein. Arrange for inspection of work by the inspectors and give the inspectors all necessary assistance in their work of inspection.

1.5 COORDINATION

A. Coordinate work with that of the other Contractors and/or other trades doing work on the project. Examine all drawings and specifications of other trades for construction details and coordination. Make every reasonable effort to provide timely notice of work affecting other trades to prevent conflicts or interference as to space requirements, dimensions, openings, block-outs, sleeving or other matters which will cause delays or necessitate work-around methods.

B. Obtain submittals and shop drawings of all equipment with electrical connections furnished under other divisions of the specification and by the Owner. Provide all wiring in accordance with specific equipment requirements. Immediately advise the Architect of any changes which may affect the contract price.

C. Special attention is called to the following items. Coordinate all conflicts prior to installation:
   1. Door swings such that switches will be located on the "strike" side of the door.
   2. Location of grilles, pipes, sprinkler heads, ducts and other mechanical equipment so that all electrical outlets, lighting fixtures and other electrical outlets and equipment are clear from and in proper relation to these items.
   3. Location of cabinets, counters and doors so that electrical outlets, lighting fixtures and equipment are clear from and in proper relation to these items.
   4. Recessing and concealing electrical materials in CMU walls, concrete construction and precast construction.
   5. At each switchboard, panelboard and motor control center location the Contractor shall monitor the work of all trades to assure that the space and clearance requirements of code are met.

D. Furnish, install and place in satisfactory condition all raceways, boxes, conductors and connections and all other materials required for the electrical systems shown or noted in the contract documents to be complete, fully operational and fully tested upon completion of the project. Raceways, boxes and ground connections are shown diagrammatically only and indicate the general character and approximate location. The layout does not necessarily show the total number of raceways or boxes for the circuits required, nor are the locations of indicated runs intended to show the actual routing of the raceways.

E. The horsepower of motors and apparatus wattage's shown on the drawings are estimated requirements of equipment furnished under other Divisions of this contract. Provide overload elements to suit actual equipment nameplate current. Advise Architect of any equipment changes or substitutions affecting electrical systems.

F. Consult the architectural drawings for the exact height and location of all electrical equipment not specified herein or shown on the drawings. Make any minor changes (less than 6'-6" horizontal) in the location of the raceways, outlets, boxes, devices, wiring, etc., from those shown on the drawings without extra charge, where coordination requires or if so directed by the Architect before rough-in.

G. Provide inserts or sleeves for outlet boxes, conductors, cables and/or raceways as required. Coordinate the installation thereof with other trades.

H. The Contractor will not be paid for relocation of work, cuttings, patching and finishing required for work requiring reinstallation due to lack of coordination prior to installation.

1.6 WARRANTY

A. Refer to General Conditions of the Contract.

1.7 CORRECTION OF WORK

A. Within one year after the date of Substantial Completion of the work, the Contractor shall correct any work found to be not in conformance with the Contract Documents promptly after written notice from the owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive acceptance of the work under this Contract and termination of the Contract. The Owner shall give such notice promptly after discovery of the condition.

1.8 SUBMITTALS AND SHOP DRAWINGS

A. Submittals and Shop Drawings: Schedule so as not to delay construction schedule and no later than 60 days after award of contract, submit common brochure(s) with index and divider tabs by specification section, containing all required catalog cuts. Allow two weeks for review for each submittal and resubmittal.

Incomplete submittals and shop drawings which do not comply with these requirements will be returned for correction, revision and resubmittal. See General Conditions for format, quantity, etc.

B. Submit in a three ring binder with hardboard covers. Submittals shall show:
   1. Indicate listing by UL or other approved testing agency.
   2. Highlight with yellow or blue marker adequate information to demonstrate materials being submitted fully comply with contract documents.
   3. Review and check all material prior to submittal and stamp "Reviewed and Approved".

C. Shop drawings shall show:
   1. Ratings of items and systems.
   2. How the components of an item or system are assembled, interconnected, function together and how they will be installed on the project.
   3. System layout floor plans with complete device layout, point-to-point wiring connection between all components of the system, wire sizes and color coding.
   4. Coordinate with other division shop drawings and submittals. Identify interface points and indicate method of connection.

D. The Contractor agrees:
   1. Submittals and shop drawings processed by the Architect are not change orders.
   2. The purpose of submittals and shop drawings by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept.
   3. Submittals demonstrate equipment and material Contractor intends to furnish and install and indicate detailing fabrication and installation methods Contractor intends to use.
   4. To accept all responsibility for assuring that all materials furnished under this Division of the specifications meet, in full, all requirements of the contract documents.
   5. To pay for Engineers review cost of submittal review beyond one resubmittal.

E. The Engineer's review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Corrections or comments made during this review do not relieve contractor from compliance with the requirements of the drawings and specifications. Contractor is responsible for: Dimensions which shall be confirmed and correlated at the job site; fabrication process and techniques of construction; coordination of his work with that of all other trades; performing his work in a safe and satisfactory manner.

F. Submittals and shop drawings are required per the submittals schedule at the end of this Section.

1.9 PROJECT CLOSE-OUT

A. Coordinate with close-out provisions in Division 01 - General Requirements.

B. Request For Final Punchlist
   1. To request a final electrical punch list, forward a letter to Sparling, Inc. stating; "The electrical work on this project is complete, all punch list items to date are complete, items a. - n. in the Punchlist Procure paragraph in Section 260500 - Common Work Results For Electrical are complete and the project is ready for final punch list observation."
   2. Project Punchlist Procedure: Perform the following procedures for project closeout of electrical portions of work.
      a. Perform testing, tests and documentation per Section 260126 - Maintenance Testing of Electrical Systems.
      b. Provide engraved nameplates on electrical equipment.
      c. Refinish electrical equipment finishes which are damaged.
      d. Clean light fixtures per Section 260500 - Common Work Results For Electrical.
      e. Color code junction boxes per Section 260533 - Raceways and Boxes For Electrical Systems.
      f. Provide spare fuses and cabinet per Section 262813 - Fuses.
      g. Insert word processed (typed) Panel Schedules in all new and existing panelboards with actual "as-built" circuit descriptions.
      h. Number all circuit breakers.
      i. Obtain final electrical permit inspection. Include copies in O and M manual.
      j. Provide written warranty in O and M per the General Conditions of the Contract.
      k. Furnish Record Drawings per this section. Obtain signature on Job Completion Form.
      l. Furnish O and M Manuals per this section. Obtain signature on Job Completion Form.

m. Give instruction periods to owner's personnel per this section. Obtain signature on Job Completion Form.
n. To request final acceptance of project, fill out Job Completion Form in this section and forward to Sparling. Note: If inspectors have not signed form, a copy of signed-off permits will suffice.
o. Include with Job Completion Form, a copy of the final punch list with the word "DONE", and the date and Contractor's initials after each item on the list.

1.10 ELECTRICAL EQUIPMENT OPERATION AND MAINTENANCE (O and M) MANUALS

A. Provide O and M manuals required in Division 01 - General Requirements plus one manual for Sparling for all equipment furnished under Division 26 - Electrical of the specifications. Submit a preliminary copy, complete except for the bound cover, 60 days prior to completion of the project for checking and review. Deliver final bound corrected copies as noted in Division 1 - General Requirements plus a copy to Sparling 20 days prior to scheduled instruction periods. Obtain a receipt for the manuals and forward a copy of the receipt to the Engineer with the Job Completion Form.

B. The information included must be the exact equipment installed. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.

C. These O and M manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the project. Present and arrange information in a logical manner for efficient use by the Owner's operating personnel. The information provided shall include but not be limited to the following:
1. Equipment manufacturer, make, model number, size, nameplate data, etc.
2. Description of system configuration and operation including component identification and interrelations. A master control schematic drawing(s) may be required for this purpose.
3. Dimensional and performance data for specific unit provided as appropriate.
4. Manufacturer's recommended operation instructions.
5. Manufacturer's recommended lubrication and servicing data including frequency.
6. Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriate). Parts lists shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.
7. Shop drawings.
8. Wiring diagrams.
9. Signal equipment submittals shall contain step-by-step circuit description information designed to acquaint maintenance personnel with equipment operation in each mode of operation.
10. A complete list of local (nearest) manufacturer representative and distributor contacts for each type of equipment and manufacturer. Include name, company, address, phone, fax, e-mail address, and web site.

D. Furnish complete wiring diagrams for each system for the specific system installed under the contract. "Typical" line diagrams will not be acceptable unless revised to indicate the exact field installation.

E. Group the information contained in the manuals in an orderly arrangement by specification index. Provide a typewritten index and divider sheets between categories with identifying tabs. Bind the completed manuals with hard board covers not exceeding 5" thick. (Provide two or more volumes if required.) Signal and communication systems shall be in separate volumes. Imprint the covers with the name of the job, Owner, Architect, Electrical Engineer, Contractor and year of completion. Imprint the back edge with the name of the job, Owner and year of completion. Hard board covers and literature contained may be held together with screw post binding.

1.11 INSTRUCTION PERIODS

A. After substantial completion of the work and 20 days after the O and M manuals have been delivered to the owner and after all tests and final inspection of the work by the Authority(s) Having Jurisdiction; demonstrate the electrical systems and instruct the Owner's designated operating and maintenance personnel in the operation and maintenance of the various electrical systems. The Contractor shall arrange scheduled instruction periods with the Owner. The Contractor's representatives shall be superintendents or foremen knowledgeable in each system and suppliers representatives when so specified. When more than one training session is specified, the second session shall be 30 to 90 days after the first as agreed to by the Owner.

B. Include in each instruction session an overview of the system, presentation of information in maintenance manuals with appropriate references to drawings. Conduct tours of the building areas with explanations of

maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures and adjustment locations.

C. Include the following scheduled instruction periods:

		1st Session	2nd Session
1.	Power Distribution System	4 hours	4 hours
2.	Lighting Control and Dimming System	4 hours	4 hours
3.	Power Generation Equipment and Transfer Switches	4 hours	4 hours

D. Factory trained suppliers representatives shall provide instruction for lighting control/dimming, power generation and transfer switches, paralleling low voltage switchgear, static uninterruptible power supply and transient voltage suppression system(s).

E. Provide one professionally produced digitally recorded or video tape of each training session as required by each section.

1.12 RECORD DRAWINGS

A. Continually record the actual electrical system(s) installation on a set of prints kept readily available at the project during construction. These prints shall be used for this purpose alone.
1. Mark record prints with red erasable pencil. Mark the set to show the actual installation where the installation varies substantially from the work as originally shown.
2. Accurately locate with exact dimensions all underground and underslab raceways and stub-outs.
3. Note changes of directions and locations, by dimensions and elevations, as utilities are actually installed.
4. Include addenda items and revisions made during construction.
5. Erase conditions not constructed or "X-out" and annotate "not constructed" to clearly convey the actual "as constructed" condition.
6. Organize record drawings sheets in manageable sets, bind and print suitable titles, dates and other identification on the cover of each set.

B. Transfer the changes marked up on the record prints into AutoCAD 2008 (or higher) at the completion of the work. Provide two (2) sets of prints, one set of fixed line reproducible drawings and one set of AutoCAD drawing files on 3-1/2" floppy disks, CD Rom or Zip disk. Transmit drawings, CAD files and the record drawing mark-ups to the Architect. Final payment to the contractor will not be authorized until these documents have been submitted to and accepted by the Architect.

1.13 FINAL ACCEPTANCE REQUEST

A. Submit to the Architect, with a copy to the Sparling Engineer, a Sparling Job Completion Form (form attached in this section) properly filled out prior to the time final acceptance of the electrical work is requested.

1.14 ABBREVIATIONS AND DEFINITIONS

A. When the following abbreviations and definitions are used in relation to the work for Division 16 they shall have the following meanings:

Item	Meaning
AHJ	Authority Having Jurisdiction.
Boxes	Outlet, Junction or Pull Boxes.
Code	All applicable codes currently enforced at project location.
Compression	Compressed using a leverage powered (hydraulic or equivalent) crimping tool.
Connection	All materials and labor required for equipment to be fully operational.
Exterior Location	Outside of or penetrating the outer surfaces of the building weather protective membrane.
Fully Operational	Tested, approved, and operating to the satisfaction of the AHJ, manufacturer and contract documents.
Furnish	Deliver to the jobsite
Install	To enter permanently into the project and make fully operational.
Kcml	Thousand circular mils (formerly MCM).
Mfr.	Manufacturer.
NEC	National Electrical Code, National Fire Protection Association,

	Publication #70.
Noted	Shown or specified in the contract documents.
Provide	Furnish and install.
Required	As required by code, AHJ, contract documents, or manufacturer for the particular installation to be fully operational.
Shown	As indicated on the drawings or details.
Wiring	Raceway, conductors and connections.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and equipment installed shall have been tested and listed by Underwriters Laboratories or other approved testing organization and shall be so labeled unless otherwise permitted by the Authority Having Jurisdiction (Inspector).

B. All materials to be new, free from defects and not less than quality herein specified. Materials shall be designated to insure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.

C. Each type of materials furnished shall be of the same make, be standard products of manufacturers regularly engaged in production of such materials and be the manufacturer's latest standard design.

D. All materials, equipment and systems furnished that include provisions for storing, displaying, reporting, interfacing, inputting, or functioning using date specific information shall perform properly in all respects regardless of the century. Any interface to other new or existing materials, equipment or systems shall function properly and shall be century compliant, both in regards to information sent and received.

2.2 SUBSTITUTION OF MATERIALS

A. No Substitute:
Where a specified product is indicated "no substitute", it is the intent of this specification to require new materials to be compatible with the existing installation or as specifically requested by the owner. To this end certain materials and systems no substitution will be allowed.

B. Prior to Bid Opening:
Acceptance of products other than those specified will be issued by addendum to the bid documents only after the following requirements are met and the proposed listed material is determined to meet or exceed the requirements:
1. Requests for listing to be original material, clearly indicating the product fully complies with contract documents and be neatly marked with yellow felt tip marker to clearly define and describe the product for which listing is requested.
2. Include certified laboratory test report for lighting fixtures.
3. Samples shall be submitted if requested.
4. Requests shall be received 10 days prior to bid opening.
5. Requests containing insufficient information to confirm compliance with contract documents will not be considered.

C. After Award of Contract:
Substitution of products will be considered after award of contract only under the following conditions:
1. The Contractor shall have placed orders for specified materials promptly after contract is awarded, and the specified products cannot be delivered to the project to meet the Owner's construction schedule.
2. The reason for the unavailability is beyond the Contractor's control, i.e., due to strikes, bankruptcy, discontinuance of manufacturer, acts of God.
3. The specified product is no longer manufactured.
4. There is compelling economic advantage to the Owner.

D. In all cases, should a substituted material result in requiring electrical system or building modifications; the Contractor alone shall pay all costs to provide these modifications including all costs to the Engineer and Architect for redesign, and updating of record drawings required to accommodate the required modifications.

2.3 NAMEPLATES

A. Provide nameplates per Section 260553 - Identification for Electrical Systems.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft. Handle all equipment carefully to prevent damage, breakage, denting, and scoring of finishes. Do not install damaged equipment.

B. Store products subject to damage by the elements above ground, undercover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instruction.

3.2 CUTTING BUILDING CONSTRUCTION

A. Obtain permission from the Architect and coordinate with other trades prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills or concrete saws except where space limitations prevent the use of such tools.

B. All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that particular building trade.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire rated floor and wall assemblies to maintain fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 section "Firestopping".

3.4 PAINTING

A. Items furnished under this Division that are scratched or marred in shipment or installation shall be refinished with touchup paint selected to match installed equipment finish.

3.5 EQUIPMENT CONNECTION

A. For equipment furnished under this or other Divisions of the specifications, or by owner, provide complete all electrical connections necessary to serve such equipment and provide required control connections to all equipment so that the equipment is fully operational upon completion of the project. Provide disconnect switch as required by code whenever an equipment connection is shown on the drawings.

B. Investigate existing equipment to be relocated and provide new connections as required.

3.6 CLEAN UP

A. Contractor shall continually remove debris, cuttings, crates, cartons, etc., created by his work. Such clean up shall be done daily and at sufficient frequency to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation, Contractor shall carefully clean cabinets, panels, lighting fixtures, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.

1. Wipe surfaces of electrical equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
2. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent, high pressure sodium, metal halide, and mercury vapor fixtures to comply with requirements for new fixtures.

3.7 TESTING AND DEMONSTRATION

A. Demonstrate that all electrical equipment operates as specified and in accordance with manufacturer's instructions. Perform tests in the presence of the Architect, Owner or Engineer. Provide all instruments, manufacturer's operating instructions and personnel required to conduct the tests. Repair or replace any electrical equipment that fails to operate as specified and or in accordance with manufacturer's requirements.

SPARLING ELECTRICAL JOB COMPLETION FORM

PROJECT NAME: PSU Lincoln Hall Seismic and Systems Upgrade
PROJECT LOCATION: _____
DATE: _____

A. Electrical Inspectors Final Acceptance (Copy of certificate attached.)

_____
Name Agency Date

B. Fire Marshal's Final Acceptance of Fire Alarm System (Copy of certificate attached.)

_____
Name Agency Date

C. The following systems have been demonstrated to Owner's representative.

1. Power Distribution System _____
Owner's Rep. Date

2. Lighting Control and Dimming System _____
Owner's Rep Date

3. Power Generation Equipment and Transfer Switches _____
Owner's Rep Date

D. Record Drawings
Attached Transmitted previously to _____
Date

E. O and M Manuals
Attached Transmitted previously to _____

F. Test Reports
Attached Transmitted previously to _____
Date

G. The work is complete in accordance with contract documents and authorized changes except for

_____
and the architect/engineer's representative is requested to meet with
_____ at _____ on _____
Supervisor of Electrical Work Time Date

_____ _____
Contractors Rep. Signature Date

SPARLING SUBMITTAL LIST PSU LINCOLN HALL SEISMIC AND SYSTEMS UPGRADE

SECTION	DESCRIPTION	SUBMIT RECEIVE DATE	STATUS
260126	MAINTENANCE TESTING OF ELECTRICAL SYSTEMS		
260128	THERMOGRAPHY		
260519	COPPER CONDUCTORS AND CABLES		
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS		
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS		
260536	CABLE TRAYS FOR ELECTRICAL SYSTEMS		
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS		
260923	LIGHTING CONTROL DEVICES		
262726	WIRING DEVICES		
262813	FUSES		
265100	INTERIOR LIGHTING		

END OF SECTION

EXISTING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 RELATED WORK

A. Same as in Section 260500 - Common Work Results For Electrical.

1.3 EXISTING SYSTEMS MAINTAINED

A. Prior to bidding, existing systems and systems adjacent to the work shall be investigated thoroughly. Any damage resulting from performance of work under this contract shall be repaired to assure continuing operation and integrity during and at completion of the project at no increase in contract cost.

B. Any existing wiring serving devices to remain in service and which is interrupted by work performed under this contract shall be rerouted to maintain circuit continuity. Contractor shall assume the risk of maintaining existing systems except relocation of wiring of #2 AWG and above shall be considered an additional cost if not shown to be relocated. If such wiring is found the Contractor shall notify Architect of wiring location, reason it must be removed and cost of relocation and receive the Owner's approval before proceeding with the work.

C. The building will continue operation during the work and it is essential that no systems operation be interrupted unless scheduled with the Architect. Contractor shall assume responsibility for unscheduled interruptions and expedient repair.

1.4 EXISTING SYSTEMS CONCEALED

A. The electrical drawings show portions of the existing electrical systems which are to remain, be removed or be modified as a part of the Contractor's work. Concealed features of the existing systems are derived from record drawings and the Engineer's best judgment of the configuration, but no guarantee is made as to their correctness.

B. The Contractor shall inspect the existing installation prior to bidding and shall make his own judgment as to the work required to provide a complete installation within the intent of the contract documents.

1.5 DEMOLITION WORK

A. All demolition work required under this contract is not shown on the drawings.

B. The demolition drawings show portions of the existing systems which are derived from record drawings. The contractor shall assume there is 20% more electrical systems than what is shown on the demolition drawings.

C. The Contractor shall inspect the existing installation prior to bidding and shall make his own judgment as to the work required to provide complete demolition within the intent of the contract documents.

1.6 TEMPORARY ELECTRICAL EQUIPMENT

A. Removing, temporary hanging by chains and reinstalling in ceilings of light fixtures, speakers, detectors, exit signs and other electrical equipment is not shown on the drawings. The Contractor shall investigate the ceiling demolition work and include this work in the bid. The sequence of work shall be (1) Remove and store fixtures, detectors and speakers along with removal of ceiling, (2) Provide temporary support for wired fixtures and devices to be reinstalled in new ceiling at approximately the same location. Use chains for lighting fixture support, (3) Clean and reinstall in the new or replaced ceilings. Provide new lamps when so noted. Provide temporary relocation of exit signs to original location when exit is reactivated.

1.7 WORK OUTSIDE OF REMODEL AREAS

A. Caution - this work is not shown on the contract documents. Provide new wiring systems in concealed ceiling spaces to switchboards, panelboards, communication and signaling and system control panels. Remove and relocate electrical equipment in the way of other trades work installed under this contract. Spaces above existing ceilings are highly congested. Route wiring around obstructions and provide pull boxes per code.

1.8 PREMIUM TIME

A. Premium time shall be included in the Base Bid for electrical system(s) outages and for other work as required by the schedule, as shown on the drawings and as noted in other Divisions of the Specifications.

PART 2 - PRODUCTS

2.1 EXISTING MATERIALS

A. All materials which are a part of the building shall remain the property of the Owner.

2.2 EXISTING MATERIALS TO BE REINSTALLED

A. Existing materials and equipment (except interior, undamaged raceways) that are removed as a part of the work or stored in surplus shall not be reinstalled as a part of the new systems unless specifically noted or authorized in writing by the Owner. Forward a copy of the authorization to the Engineer. The requirements of the specifications (i.e., condition, installation, testing, etc.) shall apply as if the materials were new, furnished by the Contractor.

2.3 EXISTING MATERIALS NOT TO BE REINSTALLED

A. In coordination with the Architect, these materials shall be made available for his inspection and decision as to whether the Owner will retain possession. Items selected for retention shall be turned over to the Owner. These items shall be delivered to a location on the premises selected by the Owner. Take reasonable care to avoid damage to this material. If the Contractor fails to conform to this requirement, he shall purchase and turn over to the Owner replacement material of like kind and quantity.

B. All material not selected for retention by the Owner and debris shall be legally disposed of by the Contractor.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Examine the structure, building, and conditions under which electrical work is to be installed for conditions detrimental to proper and timely completion of electrical work. Do not proceed with work until deficiencies or detrimental conditions have been corrected. Report deficiencies or detrimental conditions of existing electrical work which might be unsuitable to connect with or receive other work. Failure to so report shall constitute acceptance of other work as being fit and proper for the reception of electrical work.

3.2 DEMOLITION

A. Signaling and communication systems, other electrical equipment free standing or surface mounted, raceway (exposed) and conductors; which are no longer in service presently or as a result of this contract shall be removed. Unused flush mounted devices, outlet and other boxes in finished areas shall be removed from wall and the remaining hole patched to match adjacent wall surfaces. Unused raceways and sleeves shall be cut flush at ceiling, floor or wall and filled with grout. Unused raceways above accessible ceilings shall be removed.

B. Contractor shall remove all floor, wall or ceiling mounted electrical equipment in the "Demolition Area" indicated on the drawing even if the equipment/or device is not shown on the project drawings. If Contractor questions whether a particular device is to be removed notify the Architect noting type and location of device. If so directed the Contractor shall maintain the existing device in service without any change in contract price.

3.3 EXISTING SYSTEMS MAINTAINED

A. General. Reroute existing circuits that are interrupted as a result of this contract that serve devices to remain in service.
   1. Power Circuits (Including removal or relocation of existing panelboards).
      a. Prior to demolition work trace out and identify each branch circuit and feeder circuit that serves loads in occupied areas.
      b. Provide temporary wiring, schedule outage and reconnect loads to temporary wiring.
      c. Provide new wiring in new location.
      d. Schedule outage, disconnect temporary wiring, and connect loads to new wiring. Remove temporary wiring.
   2. Signal and Communication Systems
      a. Prior to demolition trace out and identify device and systems being served.
      b. Provide temporary wiring to maintain operation of system throughout facility.
      c. Schedule outage and connect to temporary wiring and test system.
      d. Provide new wiring on new location.

e. Schedule outage, disconnect temporary wiring, and reconnect to new wiring. Remove temporary wiring.

3.4 ACCESS TO PERFORM WORK

A. Carefully remove, store or temporarily hang and re-install in undamaged condition all electrical equipment, lighting fixtures and ceiling tiles where access to perform work is required. Clean prior to re-installation. Provide new lamps when so noted.

3.5 NEW DEVICES IN REMODEL AREAS

A. Provide flush mounting for devices in existing walls. Fish conduit in wall. Where existing boxes are indicated to be reused, extend box as necessary and provide new devices and plates.

B. Contractor is cautioned that the existing building contains clay tile and concrete walls. New devices may require cutting and patching, and it shall be the responsibility of the contractor to provide all cutting and patching required for the installation of the Division 16 work. Contractor shall investigate existing areas prior to bid and shall include all costs of such work in the bid.

END OF SECTION

COPPER 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.

1.2 SUMMARY

A. Section Includes
   1. Building wire and cable
   2. Remote control and signal circuits
   3. Splices, connectors, and terminations
   4. Armored cable type AC and metal clad cable type MC

B. Substitutions: Substitute products will be considered only under the terms and conditions of Section 260500 - Common Work Results For Electrical.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM).

B. National Electrical Manufacturers Association (NEMA).

C. Underwriter’s Laboratories, Inc. (UL).

1.4 SUBMITTALS

A. Make submittals in accordance with Section 260500 - Common Work Results for Electrical.

B. Submit product data for type MC cables, connectors and manufacturer's recommended sheath cutting procedure including special tools.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. General
   1. Copper conductor, single insulated wire.
   2. ASTM B1 solid conductors; ASTM B8 for stranded conductors
   3. 600 volt insulation class, 90°C maximum operating temperature for dry and wet locations

B. Thermoplastic Insulated Wires and Cables
   1. Type THHN/ THWN, UL 83 listed, comply with NEMA WC5.

C. Rubber Insulated Wires and Cables
   1. Type XHHW-2, UL 44 listed, comply with NEMA WC3.
   2. Type USE-2, UL 44 listed, comply with NEMA WC3.

2.2 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1
   1. Copper conductor, single insulated wire
   2. Insulation type THHN/ THWN (90°C), 600 volt insulation class
   3. Type XHHW for ambient temperature less than 0°C
   4. UL 83 listed, ASTM B1 solid conductors; ASTM B8 for stranded conductors

B. Class 2 and 3
   1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted
   2. 300 volt XLPE insulation rated 105°C
   3. UL listed for use in the space in which circuits will be installed

2.3 SPLICES, CONNECTORS and TERMINALS

A. Splices
   1. Electrical Tape: 7 mil thick, PVC backing with flexibility and adhesion at 0°F.
   2. Pre-Stretched Tubing: EPR pre-stretched tubular rubber sleeve suitable for insulation of voltages up to 600 volts. 3M PST series or equivalent.
   3. Heat Shrink Tubing: Thermally stabilized cross-linked polyolefin with 3 to 1 expansion and internal adhesive sealant. Thomas and Betts Shrink-Kon, Raychem, or equivalent.

4. Resin Filled Insulators: Plastic mold body with pourable insulating and sealing compound. 3M Scotchcast 82 or 90 series or equivalent.

B. Connectors
1. No. 10 AWG and Smaller: Pre-insulated “twist-on” type with integral spring and insulated housing per UL 486C. Manufacturers: Ideal, Thomas and Betts, or 3M.
2. No 8 AWG and Larger: Bolt or compression set type per UL 486C. Provide two hole compression set connectors for ground bus applications. Manufacturers: Thomas and Betts, O.Z. Gedney.

C. Terminals
1. Stranded Conductors #10 and Smaller: Comply with UL 486A
2. Heavy wall thickness copper, tin plated with nylon insulation
3. Thomas and Betts Sta-Kon Terminals
4. Cable ties - nylon locking type. Thomas and Betts Ty-Rap

2.4 TERMINATIONS

A. Compression set, bolted, or screw type lug or direct to bolted or screw type terminal.

2.5 PLASTIC CABLE TIES

A. Nylon or approved, locking type.

2.6 METAL CLAD CABLE (TYPE MC)

A. Manufacturer: AFC Cable Systems, Alflex, Interflex, Okonite, Rockbestos, Southwire

B. Circuit Conductors
1. Conductors: Soft drawn solid copper with 2, 3, or 4 insulated conductors in sizes #12 AWG or #10 AWG. Stranded copper conductors shall be class B stranded or equivalent.
2. Insulation: Type THHN insulation rated for 90° C dry and rated for 600 volts.

C. Cable Assembly
1. All insulated circuit conductors and any insulated grounding conductors shall be cabled together and contained under an overall nonmetallic tape covering.
2. A single bare aluminum grounding/ bonding conductor shall be placed outside of the nonmetallic tape covering and have the same lay (twist) as the insulated conductor assembly.

D. Metal-Clad Sheath/ Armor Assembly
1. Interlocking galvanized steel or aluminum or continuous aluminum corrugated sheath.
2. Aluminum interlocking metal tape shall be formed and helically wrapped around the cable assembly such that the interlocked armor and aluminum ground/ bonding conductor are in intimate contact through the entire cable.

E. Equipment Grounding Conductors
1. Insulated Copper Conductor: Each cable shall contain a green insulated ground conductor.

F. Connectors
1. UL listed for use with the type of cable installed.
2. Manufacturer: AFC Cable Systems, Crouse-Hinds, Bridgeport Thomas and Betts.

PART 3 - EXECUTION

3.1 WIRE and CABLE

A. Sizing
1. Use stranded conductors for #8 AWG and larger. Conductors of #10 and #12 AWG may be solid or stranded at the contractor’s option.
2. Minimum power and lighting branch circuit requirement of #12 AWG.
3. Oversize neutral conductors for receptacle circuits using common neutrals, including those to power poles and powered furniture partitions for possible non-linear loads. See drawings for sizing criteria.

B. Color Coding
1. Color code wire in accordance with the coding shown below:

	208Y/120V	480Y/277V
A Phase (Left bus in panel):	Black	Brown
B Phase (Center bus	Red	Orange

in panel)		
C Phase (Right bus in panel)	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green
Isolated Ground	Grn/Yel*	Grn/Yel*

2. If large conductors cannot be purchased with the correct insulation color, color code the conductors with wire and cable markers of the appropriate color. Completely encircle the conductor with color coding tape for a minimum length of 6 inches at all accessible locations.
3. In the event that separate neutrals are specified with each phase conductor, provide a white neutral conductor with a tracer of the same color as the corresponding phase conductor.

C. Installation
1. Utilize type THHN/THWN wire for all power, lighting circuits except where the ambient temperature is below 0°C, use Type XHHW installation.
2. Install all wiring in a raceway system unless otherwise specified.
3. Install wire only after building interior has been protected from the weather.
4. Install wire only after mechanical work likely to damage wire has been completed.
5. Completely and thoroughly swab exterior raceways before installing wire.
6. Pull all conductors into a common raceway simultaneously.
7. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
8. Neatly train and lace wiring inside boxes, equipment and panelboards.
9. Provide conductor vertical supporting device as required by NEC 300-19.
10. Conductors from one system shall not be intermixed in the same raceway as another system unless shown otherwise. Examples of circuits not be to be intermixed are 480Y/277 with 208Y/120 volt circuits, emergency power, line voltage circuits with low voltage wiring, etc.

3.2 REMOTE CONTROL and SIGNAL CIRCUITS

A. Sizing - #16 AWG minimum.

B. Installation:
1. Install cables in cable tray and cable rings.
2. Provide protection for exposed cables where subject to damage.
3. Support cables above accessible ceilings; do not rest on ceiling tiles.
4. Use suitable cable fittings and connectors.

3.3 SPLICES, CONNECTORS and TERMINALS

A. Splices
1. Do not make splices without the approval of the engineer.
2. Splice wires and cables only in accessible locations such as within junction boxes.
3. Make splices to carry full capacity of conductors with no perceptible temperature rise.
4. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat shrinkable insulating tubing, or resin filled insulator.

B. Connectors
1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with the connectors being installed.
2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat shrinkable insulating tubing for splices and taps of #8 AWG copper conductors and larger.
3. Torque conductor connections to manufacturer’s recommended values.
4. Use pre-insulated “twist-on” connectors with integral spring for splices and taps of #10 AWG copper conductors and smaller.

C. Terminals
1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.

2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
3. Train wires to eliminate fanning of stands, crimp with proper tool and die.
4. Torque screw termination per manufacturer's recommended values.
5. Cable ties: Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.4 METAL CLAD CABLE (TYPE MC)

A. Uses Permitted
1. At the contractor's option, type AC and/or MC cable may be used in a concealed, dry, interior locations for conductor sizes #10 and smaller.

B. Uses Not Permitted
1. Exposed, wet, damp or exterior locations.
2. In hazardous (classified) locations except as permitted in NEC articles 501, 502, 503, 504 and 505.
3. Theaters and similar locations except as permitted in NEC 518, Places of Assembly.
4. Type AC and MC cables may not be used for circuit homeruns.
5. Type AC and MC cable may not be used for low voltage or communications systems, including fire alarm system.

C. Sizing
1. Minimum #12 AWG for power and lighting circuits.

D. Color Coding
1. Color code wire in accordance with Section 16120 - 3.1 B.

E. Installation
1. Install cable in accordance with the manufacturers recommended procedures. Cut cables only with the special tools provided by the cable manufacturer; the use of wire cutters or hacksaws for armor cutting is not permitted.
2. Install cables only after building interior has been protected from the weather.
3. Install wire only after mechanical work likely to damage wire has been completed.
4. Maintain 12" minimum clearance to high temperature (greater than 90° C) surfaces.

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.

1.2 DESCRIPTION

A. Grounding systems shall be provided for service neutral power ground and for equipment grounds and bonding as required by code.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS AND CONNECTORS

A. Copper only, sized per code. Bare or green insulated in sizes #10 AWG or larger. Green insulated for size #12 AWG.

PART 3 - EXECUTION

3.1 GROUNDING, GENERAL

A. Provide all grounding for electrical systems and equipment as required by codes and as specified herein.

B. Branch Circuit Grounding: All branch circuits in patient areas shall include an insulated green ground wire connected between the branch circuit panelboard ground bus and the wiring device (or equipment) ground terminal that the branch circuit serves. One ground wire in each branch circuit raceway, looped between ground terminals, is required. For the purposes of this code requirement, the entire project area up to a height of eight feet above the floor shall be considered to be a patient occupied area. Green tape identification (in lieu of green insulation) on ground wires is not acceptable.

3.2 GROUND RODS

A. Provide as shown and/or required. Connect the grounding conductor to each rod.

3.3 SIZE OF GROUND WIRE

A. As required by National Electric Code. Where ground wire is exposed to physical damage protect with rigid non-ferrous conduit as permitted by applicable code.

3.4 GROUND CONNECTION OF PIPING

A. Metal internal piping shall be grounded, as a part of this contract.

3.5 CONNECTION TO THE POWER GROUND BUS

A. Furnish and install connections in accordance with the codes; including but not limited to:
   1. Raceway system
   2. Electrically operated equipment and devices.

B. No device or equipment shall be connected for electrical service which has a neutral conductor connected to a grounding conductor or to the frame within the device or equipment.

3.6 METHOD OF CONNECTIONS

A. Make all ground connections and ground cable splices by thermal welding or copper compression set type connectors U.L. listed for grounding purposes. Grounding lugs, where provided as standard manufacturer's items on equipment furnished, may be used.

3.7 EXPANSION FITTINGS

A. In conduit runs requiring an expansion fitting, a bonding jumper shall be installed around the fitting to maintain continuous ground continuity.

3.8 TESTING

A. Conform to Section 260126 - Maintenance Testing of Electrical Systems

3.9 GROUND CABLE CROSSING EXPANSION JOINTS

A. Ground cables crossing expansion joints or similar separations in structures or paved areas shall be protected from damage by means of suitable approved devices or methods of installation which will provide

the necessary slack in the cable across the joint to permit movement. Stranded or other approved flexible copper run or jumper shall be used across such separations.

3.10 GROUNDING FOR PANELBOARD FEEDERS

A. Provide a grounding bushing with ground conductor sized in accordance with NEC table 250.122 to the grounding bus in the panelboard and switchboards.

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.

1.2 SUMMARY

A. This Section includes the following:
1. Hangers and supports for electrical equipment and systems.
2. Seismic restraints for electrical equipment and systems.

The below listed systems shall have a component importance factor as described below:

Ip = 1.0	**Ip = 1.5**
Normal power feeders, busways and branch circuit raceways	Essential system feeders, busways and branch circuit raceways
Normal power distribution equipment	Essential system distribution equipment
Systems equipment and raceways not specifically listed as being braced with a component importance factor of 1.5.	Essential system generator(s)
	Emergency power control system equipment and raceways
	Fire Alarm system equipment and raceways
	Nurse Call system equipment and raceways
	Voice Paging system equipment and raceways
	Cable tray
	Telecommunications Racks
	Battery Inverters

1.3 REFERENCES

A. ASTM A325: American Society for Testing and Materials - Standard Specification for Structural Bolts.

B. ASTM A603: American Society for Testing and Materials - Standard Specification for Zinc-Coated Steel Structural Wire Rope.

C. IBC: International Building Code: Adopted and amended by the Authority Having Jurisdiction.

D. ICC: International Code Council.

E. MFMA-3: Metal Framing Manufacturers Association's Metal Framing Standards Publication.

F. MSS SP-58: Manufacturers Standardization Society of the Valve and Fittings Industry Standard for Pipe Hangers and Supports - Materials, Design, and Manufacture.

G. NECA 1: National Electrical Contractors Association Standard Practices for Good Workmanship in Electrical Contracting.

H. OSHPD: Office of Statewide Health Planning and Development.

I. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.

1.4 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.5 SUBMITTALS

A. Provide submittal information in accordance with Division 1 - General Requirements, Section 260500 - Common Work Results For Electrical and requirements described in this section.

B. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.
   1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
   2. Annotate to indicate application of each product submitted and compliance with requirements.

C. Shop Drawings: Submit shop drawings indicating routing of single raceways, trapeze systems and cable trays requiring bracing. Indicate on the shop drawing the type and location of bracing to be used. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a registered structural engineer in the state of Oregon. Include the following:
   1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
   2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile, compressive, and shear loads.
      b. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Submit details and calculations for the following items:
         1) Raceway Supports
         2) Busways
         3) Electric Power Generation Equipment
         4) Bypass/ Isolation Transfer Switches
         5) Switchboards
      c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For testing agency.

G. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel"

1.7 PROJECT CONDITIONS

A. Site Class as Defined in the IBC: As noted on Structural summary.

B. S_s, Mapped Maximum Considered Earthquake Spectral Response at Short Periods: As noted on Structural summary.

C. S_1, Mapped Maximum Considered Earthquake Spectral Response at 1-Second Period: As noted on Structural summary.

D. Assigned Seismic Use Group or Building Category as Defined in the IBC: As noted on Structural summary.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of **two** times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.
   1. Manufacturers:
      a. Cooper B-Line; a division of Cooper Industries.
      b. ERICO International Corporation.
      c. Allied Support Systems; Power-Strut Unit.
      d. GS Metals Corp.
      e. Michigan Hanger Co., Inc.; O-Strut Div.
      f. National Pipe Hanger Corp.
      g. Thomas and Betts Corporation.
      h. Unistrut; Tyco International, Ltd.
      i. Wesanco, Inc.
   2. Finishes:
      a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
   3. Channel Dimensions: Selected for structural loading and applicable seismic forces.

C. Raceway and Cable Supports: As described in NECA 1.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers:
         1) Cooper B-Line; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc
         3) Hilti, Inc.
         4) ITW Construction Products.
         5) MKT Fastening, LLC.
         6) Powers Fasteners.
   2. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
   3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   4. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
   5. Toggle Bolts: All-steel springhead type.
   6. Hanger Rods: Threaded steel.

2.2 SEISMIC-RESTRAINT COMPONENTS

A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension, compression, shear, and pullout force of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.
1. Manufacture: International Seismic Application Technology (ISAT) (877) 999-4728.

C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
1. Manufacturers:
a. Amber/Booth Company, Inc.
b. International Seismic Application Technology (ISAT)
c. Loos and Co., Inc.
d. Mason Industries, Inc.
2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
3. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least **25** percent in future without exceeding specified design load limits.
1. Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION

A. Comply with NECA 1 for installation requirements, except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA70.

C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To New Concrete: Bolt to concrete inserts or use expansion anchor fasteners.

2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Existing Concrete: Expansion anchor fasteners.
4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
5. To Light Steel: Sheet metal screws.

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Restraint Cables: Provide slack within maximums recommended by manufacturer.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.5 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: Test pullout resistance of seismic anchorage devices.
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Record test results in tabular form and submit to architect.

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 1 Specification Sections, apply to this Section.

B. Related Sections
   1. Section 260529 - Hangers and Supports for Electrical Systems
   2. Section 270528.33 - Conduits and Backboxes For Communication Systems

1.2 SUMMARY

A. Section includes raceways, fittings, boxes, enclosures and cabinets for electrical wiring.

B. Substitutions: Substitute products will be considered only under the terms and conditions of Section 260500 - Common Work Results For Electrical.

1.3 REFERENCES

A. American National Standards Institute (ANSI)

B. National Electrical Manufacturers Association (NEMA)

C. Underwriters Laboratories, Inc. (UL)

D. National Fire Protection Association (NFPA)

1.4 SUBMITTALS

A. Make submittals in accordance with Section 260500 - Common Work Results For Electrical. Submit product data only for surface raceways and fittings, wireways, enclosures and cabinets.

1.5 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT (RMC)

A. Rigid Steel Conduit: ANSI C80.1, UL 6.

B. Intermediate Metal Conduit: ANSI C80.6, UL 1242.

C. Fittings: NEMA FB1, UL 514B, galvanized malleable iron or non-corrosive alloy threaded fittings. Erickson and watertight split couplings are permitted. Set screw and running thread fittings are not permitted.

D. Conduit Bodies and Fittings Manufacturers: American Electric; Construction Materials Group, Crouse-Hinds; Div. of Cooper Industries, Emerson Electric Co.; Appleton Electric Co., Hubbell, Inc.; Killark Electric Manufacturing Co., Lamson and Sessions; Carlon Electrical Products, O-Z/Gedney; Unit of General Signal, Scott Fetzer Co.; Adalet-PLM, Spring City Electrical Manufacturing Co., Link Seal, Thomas and Betts.

2.2 ELECTRIC METALLIC TUBING (EMT)

A. Hot dip galvanized, electrogalvanized or sherardized, steel tubing, ANSI C80.3, UL 797.

B. Fittings: NEMA FB1 UL 514B, steel or malleable iron, compression or set screw. Indentor, drive-on, die cast or pressure cast fittings not permitted.

C. Conduit Bodies and Fittings Manufacturers: American Electric; Bridgeport, Construction Materials Group, Crouse-Hinds; Div. of Cooper Industries, Emerson Electric Co.; Appleton Electric Co., Hubbell, Inc.; Killark Electric Manufacturing Co., Lamson and Sessions; Carlon Electrical Products, O-Z/Gedney; Unit of General Signal, Scott Fetzer Co.; Adalet-PLM, Spring City Electrical Manufacturing Co., Link Seal, Thomas and Betts.

2.3 FLEXIBLE METAL CONDUIT (FMC)

A. UL 1, galvanized, or zinc coated flexible steel or aluminum for dry locations. Flexible metallic tubing not permitted. Fittings: malleable iron or steel.

B. Liquidtight Flexible Metal Conduit. UL 360, PVC weatherproof cover over flexible steel conduit. Fittings: galvanized or zinc coated.

2.4 SURFACE RACEWAY

A. Surface Metal Raceway: Galvanized steel with snap on covers. Manufacturer's standard ivory or buff painted finish. UL 5.

B. Types, sizes, and channels as indicated on drawings and required for each application with fittings that match and mate with raceways.

C. Manufacturers: Subject to compliance with the requirements, manufacturers offering products that may be incorporated into the work include: Airey-Thompson Co., Inc.; A-T Power Systems, American Electric; Construction Materials Group, Butler Manufacturing Co.; Walker Division, Wiremold Co. (The); Electrical Sales Division, Mono Systems, Hubbell Wiring Systems Inc.

2.5 RIGID NON-METALLIC CONDUIT (RNC)

A. Schedule 40 and 80: UL 651.

B. Type EB and B: UL 651, NEMA TC6.

C. Fittings: NEMA TC3.

2.6 EXPANSION FITTINGS

A. Malleable iron, hot dip galvanized allowing 4" (100mm) (+/- 2" (50mm)) conduit movement. OZ/Gedney AX Series or equivalent by manufacturer listed in 2.1.D.

2.7 RACEWAY PENETRATION SEALS

A. Thruwall and Floor Seals: New construction - OZ/Gedney FSK Series. Existing construction - OZ/Gedney CSM Series or equivalent by manufacturer lists in 2.1.D.

2.8 RACEWAY SEALING FITTINGS

A. For one through four conductors: OZ/Gedney CSB Series.

B. For greater than four conductors: OZ/Gedney EYA Series with sealing compound.

C. Low temperature or hazardous locations: OZ/Gedney EYA Series with sealing compound.

2.9 VERTICAL CABLE SUPPORTS

A. Factory-fabricated assembly consisting o threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables. Body shall be malleable iron.
   1. OZ/Gedney Type S or equivalent by manufacturer listed in 2.1.D.

2.10 METAL WIREWAYS

A. Material: Sheet metal, size and shape as indicated. Manufacturer's standard finish. UL 870.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Manufacturer: Subject to compliance with the requirements, manufacturers offering products that may be incorporated into the work include: Hoffman Engineering Co., Keystone/Rees, Inc., Square D Co., Circle AW, B-Line.

D. Wireway Covers: As indicated.

2.11 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.12 OUTLET JUNCTION AND PULL BOXES

A. Interior Wiring:
   1. Outlet and Pull Boxes. Pressed steel, zinc coated with plaster ring where applicable. NEMA OS1, UL 514A.
   2. Large Junction and Pull Boxes. Fabricated sheet steel, zinc coated or baked enamel finish, with return flange and screw retained cover.
   3. Concrete and Masonry. Specifically designed boxes for casting in concrete or mounting in masonry walls for that purpose.
   4. Mounting. Provide boxes with fan side box support Caddy J1A series or Caddy quick mount H series.

B. Exterior Wiring:
   1. Above Grade:
      a. Outlet and junction boxes: Cast or malleable iron or cast of corrosion resistant alloy, complete with conduit hubs, compatible with raceway to which it is connected. NEMA FB1.
      b. Pull boxes: Fabricated steel and hot dipped galvanized complete with malleable iron hubs.
      c. All boxes labeled for damp (NEMA 3R) or wet (NEMA 4) locations as applicable.
   2. Below Grade:
      a. Where exposed to earth: Constructed of fiberglass or plastic with size, configuration, and cover as required by the particular installation.

2.13 SOUND ISOLATION PADS

A. Polybutene putty sheet caulking with inert fillers. Lowry's outlet box pads (available from Harry A. Lowry and Associates, 11176 Penrose St., Sun Valley, CA 91352, phone (818) 768-4661).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Interior: Use the following wiring methods:
   1. Exposed: Electric Metallic Tubing.
   2. Exposed Subject to Damage (i.e. from vehicles, carts and moving pallets including stubups in concrete): Rigid Steel or Intermediate Metal Conduit.
   3. Concealed: Electric Metallic Tubing.
   4. Connection to Vibrating Equipment (including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Flexible Metal Conduit, (except in wet or damp locations, use Liquidtight Flexible Metal Conduit) with 90° loop, maximum 6 feet long.

B. Exterior: Use the following wiring methods:
   1. Exposed: Rigid Steel Conduit or Intermediate Metal Conduit.
   2. Concealed: Rigid Steel Conduit, Intermediate Metal Conduit, or Rigid Nonmetallic Conduit.
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Liquidtight Flexible Metal Conduit.
   4. Boxes and Enclosures: NEMA 250, NEMA type 3R or type 4.

C. Raceways Underground
   1. Rigid Nonmetallic Conduit, schedule 40 except use extra heavy-duty schedule 80 for road crossings where not encased in concrete.
   2. Arrange and slope raceways entering building to drain away from building.
   3. Provide marker tape over underground raceways. Marker tape to read "Caution - Electric Line Buried Below". Install 1'-0" (300mm) below grade.
   4. Install underground raceways a minimum of 24" (600mm) below final grade (36" (910mm) on public property) unless otherwise noted or required.

5. Provide backfill around underground raceways. Use 3/4" (20mm) minus material 6" (150mm) above and below rigid steel conduit and intermediate metal conduit. Use clean sand 6" (150mm) above and below PVC raceways. Backfill above 6" (150mm) free of debris or rocks greater than 1" (25mm) in diameter. Space raceways 7-1/2" (190mm) minimum between centers and 3" (80mm) minimum between raceways.
6. Anchor raceways encased in concrete to prevent floating during pour.

3.3 INSTALLATION

A. Provide raceways concealed in construction unless noted otherwise or unless specifically authorized by the Architect.

B. Install raceways level and square and at proper elevations. Provide not less than 6'-6" (200cm) headroom. Where raceways are installed in exit pathways provide not less than 7'-0" headroom. Do not block access to junction boxes, valves, mechanical equipment or prevent removal of ceiling panels, etc.

C. Complete raceway installation before starting conductor installation.

D. Use raceway fittings compatible with raceways and suitable for use and location.

E. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members and follow the surface contours.
1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

F. Join raceways with fittings designed and approved for the purpose and make joints tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

G. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box. Provide bushings on all raceways 1-1/2" (40mm) and larger.

H. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

I. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.

J. Size raceways not sized on the drawings per manufacturers shop drawings, applicable standards or other section of this specification.

K. Maintain 12” (300mm) minimum clearance to high temperature (greater than 90°c) surfaces.

L. When construction involves masonry work, assemble and install raceways at the same time as the wall is erected. Avoid surface cut masonry units whenever such units are to remain unplastered or uncovered in completed construction.

3.4 RIGID METAL AND INTERMEDIATE METAL CONDUIT

A. All connections watertight.

B. Provide plastic coated rigid steel or IMC conduit for all exposed exterior raceways. Use only fittings approved for use with PVC coated raceways. Patch all nicks and scrapes in PVC coating after installing conduits.

3.5 SURFACE METAL RACEWAY

A. Verify exact mounting and locations with Architect prior to rough-in. Install parallel to a building surface (i.e., wall, ceiling, floor) and fasten to surface as recommended by manufacturer. Mount so raceway is in the least obvious location. Provide all required boxes, extensions, fittings, elbows and devices for a

complete installation. Ream all cuts smooth and provide bushings in ends of ½" (15mm) and ¾" (20mm) runs at all boxes and devices.

3.6 RIGID NONMETALLIC CONDUIT

A. May be used where permitted by code and as specified in 3.2 above. Exception: Use rigid steel for elbows, penetrations through floors and walls and stub ups. Raceway size may need to be increased to include code required ground wire. Field bends limited to less than 44 degrees, formed with manufacturer's recommended heater.

3.7 RACEWAY PENETRATION SEALS

A. Exterior wall surfaces above grade: Provide watertight seal around all raceways. For concrete construction above ground level, cast raceway in wall or core drill wall and hard pack with a mixture of equal parts of sand and cement. For other types of construction use method acceptable to Architect.

B. Exterior surfaces below grade: Provide watertight seal around all raceways. Cast raceway into wall (or floor) or use manufactured seal assembly.

C. Roofs: Provide flashed and hot mopped weatherproof seal, or a pitch pan filled and sealed to be weatherproof where raceway penetrates roof membrane. Provide a weatherhead on all raceway stubups penetrating roof.

D. Fire rated construction: Seal penetrations to maintain fire rating of construction penetrated as specified in Division 7 Firestopping.

3.8 RACEWAYS SEALING FITTINGS

A. Provide watertight seal in the interior of all raceways which pass through building roof, ground floor slab or through outside walls of the building above or below grade. Seal on the end inside the building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in a flush steel box with a blank coverplate to match finish of adjacent plates or surfaces.

Exception: Sealing fittings are not required on raceways through the floor slab when the raceway does not extend beyond the building footprint.

B. Provide sealing fittings or duct seal in j-box for all raceways entering freezers and refrigeration units.

3.9 HANGERS FOR RACEWAYS

A. Raceways 1" and larger: Provide lay-in pipe hangers on 1/4" (6mm) or larger all threaded rods attached to metal ceiling inserts or to structural members at not greater than 10'-0" (3m) on center and within 12" (300mm) of each change in direction.

B. When more than two raceways will use the same routing, group together on a channel trapeze support system supported by 3/8" (9.5mm) (minimum) threaded rods attached to metal ceiling inserts or structural members. Size supports for multiple raceways for 25% future capacity.

C. Suspended ceiling systems: Do not attach raceways to ceiling suspension system hangers. Raceways 3/4" (20mm) and smaller serving equipment located within ceiling cavity or mounted on or supported by the ceiling grid system may be supported by dedicated #12 ga. galvanized, soft annealed mild steel wire hangers. Two raceways maximum per hanger. Attach raceways with clips manufactured for the purpose.

3.10 EXPANSION FITTINGS

A. Provide expansion fittings for raceways crossing expansion joints, building separation walls, and seismic joints. Provide bonding jumper.

3.11 VERTICAL CABLE SUPPORTS

A. Provide cable support for vertical cable runs as required by NFPA 70.

3.12 STUB-UP CONNECTIONS

A. Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches (150 mm) above the floor. For future equipment connections install threaded plugs flush with floor.

3.13 OUTLET AND JUNCTION BOXES

A. Firmly anchor boxes directly or with concealed bracing to building studs or joists. Boxes must be so attached that they will not "rock" or "shift" when devices are operated.

B. Flush Mounting: Install front edge (box or plaster ring) even with the finished surface of the wall or ceiling, except for those mounted above accessible ceilings or where drawings indicate surface mounting is permitted.

C. Do not mount flush boxes back-to-back. Provide 6" (150mm) minimum horizontal separation between closest edges of the boxes. Option: Use sound isolation pads or other sound proofing method acceptable to Architect.

D. When boxes are installed in fire resistive walls and partitions provide 24” (600mm) horizontal separation between boxes on opposite sides of a wall in accordance with IBC 712.3.2. In addition, limit penetrations to 16 square inches (103 square centimeters) per penetration and not to exceed a total of 100 square inches per 100 square feet (9.3 square meters) of wall area. Option: Apply fire stop putty pads acceptable to the fire marshal.

3.14 ELECTRICAL OUTLETS

A. General: Coordinate the work of this Section with the work of other Sections and trades. Study all drawings that form a part of this contract and confer with the various trades involved to eliminate conflicts between the work of this Section and the work of other trades. Check and verify outlet locations indicated on Architectural drawings, door swings, installation details and layouts of suspended ceilings and locations of all plumbing, heating and ventilating equipment.

B. Centered on Built-In Work: In the case of doors, cabinets, recesses or similar features, or where outlets are centered between two such features, such as between a door jamb and a cabinet, make these outlet locations exact. Relocate any outlets which are located off center.

C. Vertical and Horizontal Relationships: Align outlets exactly on center lines horizontally or vertically where more than one outlet is shown or specified to be at the same elevation or one above the other. Relocate as directed all such outlets (including lighting, receptacle, power, signal and thermostat outlets) which are not so installed, at no additional cost to Owner.

D. Device Outlet Height: Measure from the finished floor to the center line, unless otherwise noted.

Switches	4 feet, set vertically
Receptacles	18 inches, set vertically or as indicated
Telephone	18 inches, set vertically or as indicated
Other	As noted or as directed by Architect

E. Ceiling Location: Locate outlet either at the corner joint or in the center of a panel for acoustical material, whichever is closer to the normal spacing. Locate all outlets in the same room in same panel position.

3.15 LIGHTING FIXTURES

A. In ceilings of Acoustical Material: Locate in accordance with approved ceiling layout plans and so that fixtures replace full size ceiling tiles wherever possible.

3.16 ELECTRICAL WORK IN COUNTERBACKS, MILLWORK AND CASEWORK

A. Provide templates, where required, to other trades for drilling and cutting to insure accurate location of electrical fixtures (outlets and devices) as verified with the Architect.

B. Provide all wiring, devices, plates and connections required by said fixtures.

3.17 CONNECTION TO EQUIPMENT

A. Provide outlet boxes of sizes and at locations necessary to serve equipment furnished under this or other Divisions and provide final connections to all equipment.

B. Outlet box required if equipment has pigtail wires for external connection, does not have space to accommodate circuit wiring or requires a wire with insulation rating different from circuit wiring used.

C. Study equipment details to assure proper coordination.

3.18 BLANK COVERS

A. Provide blank covers or plates to match coverplates specified in section 16140 over all boxes that do not contain devices or are not covered by equipment.

3.19 DEVICE BOXES CONTAINING EMERGENCY AND NORMAL DEVICES

A. Permitted only with steel barrier manufactured especially for the purpose of dividing the box into two completely separate compartments.

3.20 DEVICE BOXES CONTAINING MULTIPLE DEVICES AND WIRING RATED OVER 150 VOLTS TO GROUND AND OVER 300 VOLTS BETWEEN CONDUCTORS

A. Permitted only with steel barrier manufactured especially for the purpose of dividing the box into separate compartments for each device having exposed live parts.

3.21 JUNCTION OR PULL BOXES

A. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit the number of bends within code requirements.

B. Permanently accessible.

C. Do not intermix conductors from one system in same junction box or pull box as another system unless shown or specifically authorized otherwise.

D. In suspended ceiling spaces: Support from structure independently from ceiling suspension system.

E. The drawings do not necessarily show every pull or junction box required. Add all required boxes.

3.22 ELECTRIC WATER COOLERS

A. Conceal the electrical outlet behind the unit housing when provided for by manufacturer.

3.23 BOXES IN EARTH

A. Provide for all wire splices and as required to pull conductors. Set boxes (handholes) smaller than 3’ x 3’ (910mm x 910mm) in place on a 3" (80mm) sand or pea gravel bed. Set larger boxes with a 6" (150mm) bed.

B. Set boxes so that coverplates match the slope of, and are flush with the final surface grade.

3.24 COLOR CODING

A. Color Code all junction boxes installed in accessible ceiling spaces and exposed in unfinished areas using spray paint on the box and entire cover in the following manner:

480 Power	Brown	Telephone	Black
277V Lighting	Yellow	Nurse Call	Lt. Blue
120/208V	Unpainted	Public Address	Silver
Emergency Power	Orange	Television	Gold
Clock and Program	Green	Intrusion Alarm	Gray
Fire Alarm	Red	Intercom	White

B. Use black felt tip marker following painting to indicate the circuit numbers in 1" (25mm) high letters contained within.

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.

1.2 SUMMARY

A. This Section includes cable trays and accessories.

B. Substitutions: Substitute products will be considered only under the terms and conditions of Section 260500 - Common Work Results for Electrical.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

B. National Electrical Manufactures Association (NEMA)

C. Underwriter's Laboratories, Inc. (UL)

1.4 SUBMITTALS

A. Make submittals in accordance with Section 260500 - Common Work Results for Electrical. Submit product data for each size and type of cable tray including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies and fittings.

B. Shop Drawings: Detail fabrication and installation of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Coordination Drawings: Include floor plans and sections drawn to scale. Fully dimension all cable tray components and lengths of runs. Determine exact layout and relationships between components adjacent structural and mechanical elements. Provide 1/8" scale (minimum) floor plans showing all cable tray components including transitions, expansion joints, supports, firestopping and sound wall penetrations. Show clearances between mechanical ducts and piping. AutoCAD backgrounds will be available upon request.

1.5 COORDINATION

A. Coordinate layout and installation of cable tray with other construction elements to ensure adequate headroom, working clearance and access. Revise locations and elevations from those indicated as required to suit field conditions and as approved by Engineer.

B. Examine drawings and existing conditions above ceilings and include bends and offsets in bid price to avoid ducts, pipes, conduits, etc. Installation in existing ceilings is very difficult. Include extra labor time involved in bid price.

PART 2 PRODUCTS

2.1 MANUFACTURERS: Subject to compliance with requirements, provide products by the following:

A. Cablofil, Inc.

B. Approved Alternates:
1. Wiremold
2. GS Metals

2.2 MATERIALS AND FINISHES:

A. Cable Tray Materials: select one of the following:
1. Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.

B. Cable Tray Finishes:
1. Finish for Carbon Steel Wire after welding and bending of mesh; select one of the following:
a. Electrodeposited Zinc Plating: ASTM B 633, Type III, SC-1.

b. Powder-Coated Trays – UL classified
1) Black powder-coated surface treatment over Electrodeposited Zinc Plating (or plain steel) using ASA 61 black polyester coating.
2. Finish for Stainless Steel Wire: According to ASTM B 380.

C. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray(including UL Classified painted tray) acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe-T-Edge T-welded top side wire to protect cable insulation and installers.

D. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.

E. CF Series Cable Tray Size:
1. As shown on drawings

2.3 CABLE TRAY SUPPORTS & ACCESSORIES

A. Fittings/Supports: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions. Supports will include the FAS (Fast Assembly System) where possible so that screws, bolts, and additional tools are not required for cable tray mounting.
1. FAS System support methods to mount from ceiling and wall structures with 1/4", 3/8" or 1/2" threaded rod, if applicable
2. Splices, including those approved for electrical continuity (bonding), as recommended by cable tray manufacturer. Select one of the following splicing methods, if applicable:
a. UL Classified EDRN Fast Splice: No hardware required
b. FASLock Splice: For sweeps and bends with tray 12" (300mm) and wider.
c. UL Classified EZ T 90 kit: For Tees and 90s
d. UL Classified RADT90 kit: For 5-1/2" radius Tees and 90s
3. Accessories: As required to protect, support, and install a cable tray system. Select from the following accessories, if applicable:
a. CVN Covers, of same material and finish as cable tray; with optional cover clips.
b. COT Divider Strips, of same material and finish as cable tray.
1) COT 105, 4 inch (100mm)
2) COT 150, 6 inch (150mm)
c. Cable Routing Accessories:
1) Dropout: Bolt to tray; slotted design.
2) Cablexit: No additional hardware needed.
d. Support Accessories:
1) FS 41: Fastrut connector to mount tray to nistrut without additional hardware.
2) EZJB 5/16: J-Bolt kit to mount tray to 19" or 23" racks with FAS Profile.
3) HB-2: Wall Termination Bracket
4) Beam Supports:
5) GNDSB: Grounding Clamp to ground cable tray.
e. SZMC Kit: Seismic Bracing Kit; space 30' apart for most seismic conditions.

2.4 EQUIPMENT GROUNDING CONDUCTOR FUNCTION & GROUNDING

A. UL Classified cable trays (including painted tray) may act as Equipment Grounding Conductors.
1. Use UL Classified splicing methods to ensure cable tray is electrically continuous and bonded.
a. Ground cable trays at end of continuous run.
b. Ground continuous cable tray runs every 60 feet.
2. Test cable tray system per NFPA70B, Chapter 18 to verify grounding less than 1 ohm.
3. Ground cable trays against fault current, noise, lightning, and electromagnetic interference by mounting grounding ire to each 10' cable tray section with grounding clamp. Cablofil Model GNDSB.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install cable tray level and plumb according to manufacturers written instructions, coordination drawings, original design, and referenced standards.

B. Mount bottom of tray approximately 6" above suspended ceilings, or 8' above finished floor where no suspended ceiling exists. Maintain 10" minimum vertical spacing between multiple cable trays.

C. Support cable tray from trapeze style hangers with spacing in accordance with NEMA VE 1. Provide additional hangers on ends and two additional hangers at tees and corners. Attach brackets to structural ceiling with 3/8" threaded steel rods.

D. Brace cable tray to structure with diagonal braces spaced 30' maximum on center.

E. Support cable tray from wall brackets where trapeze hangers cannot be installed.

F. Install expansion connectors where cable tray crosses a building expansion joint. Space connectors and set gaps according to NEMA VE 1.

G. Install barriers to separate cables of different systems, such as security, communications, and data processing.

3.2 COORDINATION

A. Coordinate installation of the cable tray with mechanical ductwork, piping, structural members, fireproofing and sprinkler system piping so that tray remains accessible (minimum 1 foot clear above tray bottom) after installation. Coordinate exact routing with all trades to avoid interference.

3.3 PENETRATIONS OF BUILDING FIRE SEPARATIONS

A. Where cable tray is penetrating building fire separations, seal penetration according to Division 7 Firestopping. Seal penetration only after telephone cables and all other system distribution cables have been installed.

B. Sleeves for Future Cables: Install capped sleeves for future cables through firestopping-sealed cable tray penetrations of fire and smoke barriers.

3.4 CONNECTIONS

A. Tighten electrical connectors and joints according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 GROUNDING

A. Ground cable trays as required for conductor enclosures in accordance with NFPA 70.

B. Provide a #6 bare ground cable the length of the tray. Bond to every tray section using clamps manufactured for the purpose.

3.6 CLEANING

A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damage finishes, including chips, scratches, and abrasions.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

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.

1.2 SUMMARY

A. Section Includes:
   1. Engraved Plastic Laminate Nameplates
   2. Wire and Cable Markers

B. Substitutions: Substitute products will be considered only under the terms and conditions of Section 160500 - Common Work Results for Electrical.

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI A13.1 Operational and Warning signs.

B. Occupational Safety and Health Administration (OSHA). 29 CFR - Labor Chapter XVII Part 1910-145 "Occupational and Safety Health Standards" 1992.

1.4 SUBMITTALS

A. Make submittals in accordance with Section 160500 - Common Work Results for Electrical.

B. Submit a complete nameplate schedule to indicate nameplate size, lettering size and color.

PART 2 PRODUCTS

2.1 ENGRAVED PLASTIC LAMINATE NAMEPLATES

A. Materials: Three-layer laminated plastic with minimum nameplate dimensions of 1 3/4" high by 5" wide. Lettering height for panel or equipment identifier @ 1/4". Remaining lines @ 1/8" high with 1/8" spacing between lines.
   1. Normal System: White letters on black background.
   2. Emergency System: White letters on red background.
   3. Comply with ANSI 13.1.

B. Disconnects, Starters, Combination Starters and Other Devices
   1. Provide phenolic nameplate for each device with the following information:

      Line 1: Load served

      Line 2: Panelboard and circuit number from which device is fed

      Line 3: Fuse size or breaker size as applicable

2.2 WIRE AND CABLE MARKERS

A. Comply with ANSI A13.1, Table 3 for minimum lettering size.

B. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

C. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

D. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

E. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch (0.05 mm) thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.

PART 3 EXECUTION

3.1 ENGRAVED PLASTIC LAMINATE NAMEPLATES

A. Provide nameplates for the following:
   1. Equipment identification labels including, but not limited to: disconnect switches, motor starters, and fixed equipment.
   2. Special equipment outlet labels. (1/4" letters).

B. Degrease and clean surfaces to receive nameplates.

C. Install nameplate and label parallel to equipment lines.

D. Secure nameplate to equipment front using screws or rivets. Adhesive is unacceptable.

E. Secure nameplate to inside surface of door on panel board that is recessed in finished locations.

3.2 WIRE AND CABLE IDENTIFICATION

A. Provide wire markers for control wiring as indicated on schematic and interconnection diagrams or equipment manufacturer's Shop Drawings for control wiring.

B. Provide identification labels with the following information in accordance with NEC 210.4(d).

Conductors of power systems in this building are identified as follows:

	280Y/120V	480Y/277V
A Phase (left bus in panel):	Black	Brown
B Phase (center bus in panel):	Red	Orange
C Phase (right bus in panel):	Blue	Yellow
Neutral:	White	Gray
Equipment Ground:	Green	Green
Isolated Ground:	Grn/Yel*	Grn/Yel*

*Green with yellow tracer

1. 2.0 Mil, White Polyester, Permanent Adhesive Material. Peel-off self sticking type.
2. Lettering: Black #10 font Arial on white opaque background.
3. In electrical rooms and closets, mechanical rooms, and other similar areas, post decal on front of panel, MCC, and /or switchboard.
4. In finished areas, where panel may be painted at a later time, post decal behind circuit breaker doors or behind dead front door where decal can be easily seen when circuits are being added.

3.3 RACEWAY AND JUNCTION BOX COLOR CODING (IDENTIFICATION)

A. Identify accessible conduits routed vertically or through ceiling spaces containing medium-voltage cable (voltages greater than 600V) by painting conduits with Orange Safety (FSC-1224) paint. Stencil the legend "DANGER HIGH VOLTAGE" in Gloss Black (FSC-17038) paint minimum 2" high letters at intervals not exceeding 50 feet at visible locations.

B. Conduit Identification:
   1. In accessible ceiling spaces and exposed in unfinished areas, using an indelible marking pen, label all conduits 1" larger with panel and circuit numbers of conductors routed through the conduit. Label conduit at all wall penetrations and connections to all panels, junction boxes, and equipment served.
   2. Identify floor/wall area directly above or adjacent to medium voltage conduits within 12" of the floor or wall.

3.4 WARNING SIGNS

A. General: Provide warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to

convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.

B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either pre-printed or hand printed to convey the message; example: "DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED."

END OF SECTION

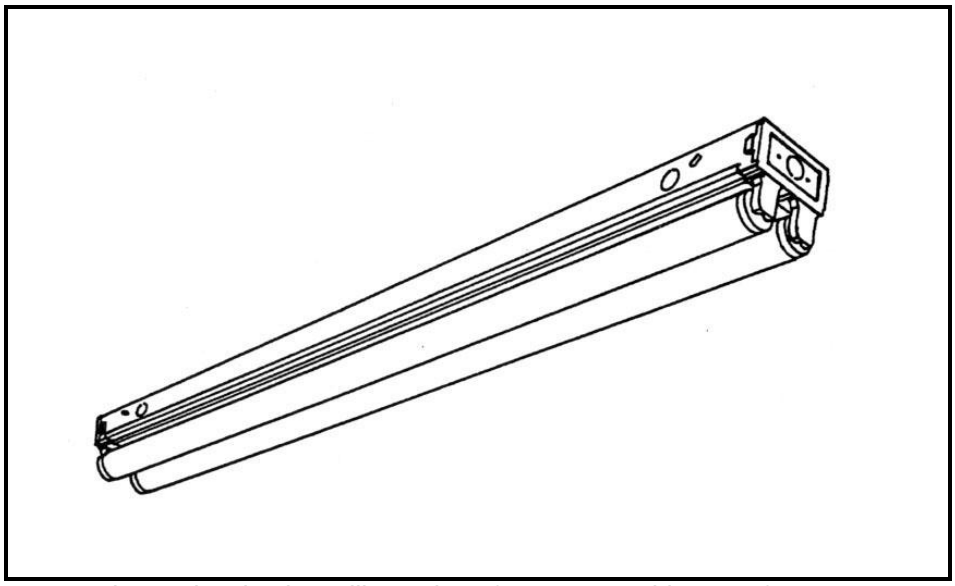
Fixture Type F1

DESCRIPTION: Chain hung two lamp fluorescent strip fixture nominal 48". Die formed steel, high reflectance baked white enamel finish. Electronic ballast. Provide wireguard.

MANUFACTURERS: Columbia CS Series; Lithonia C Series; Metalux SS Series; Day-Brite T Series; Lightolier SW Series; H.E. Williams 76 Series

LAMP: Two F32T8
WATTS: 62

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

SPARLING

111 S.W. 5TH AVE.*SUITE 1575
PORTLAND, OR 97204
PHONE: 503 / 273-0060
FAX: 503 / 273-0061

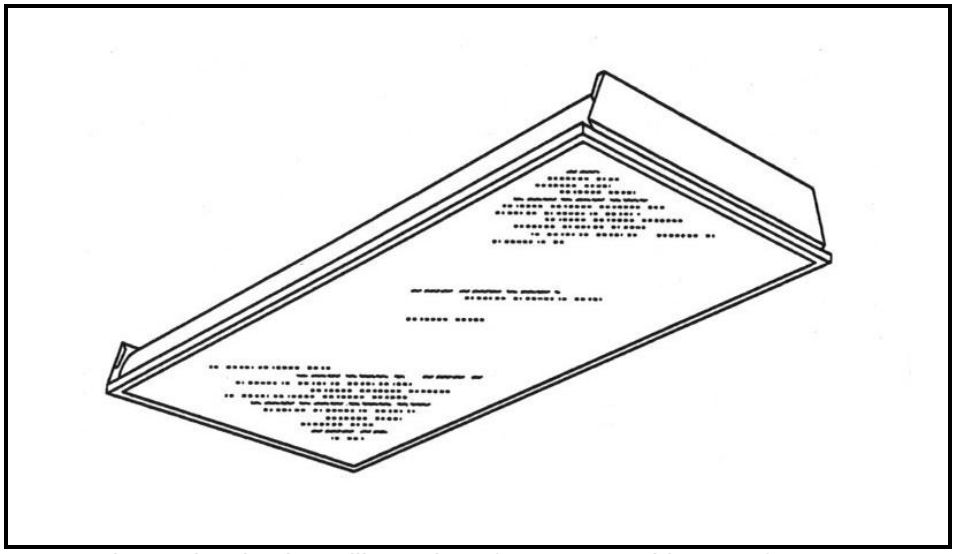
Fixture Type F2

DESCRIPTION: Recessed lensed troffer nominal 24" x 48" x 5", flush steel door with mitered corners, enclosed positive cam action latches and .125" virgin acrylic prismatic lens. Electronic ballast.

MANUFACTURERS: Columbia 4PS2 Series; Lithonia 2SP8 Series; Metalux 2GC Series; Daybrite 2TG Series; Lightolier SPS2 Series; H.E. Williams 50-S Series

LAMP: Two F32T8
WATTS: 62

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

SPARLING

111 S.W. 5TH AVE.*SUITE 1575
PORTLAND, OR 97204
PHONE: 503 / 273-0060
FAX: 503 / 273-0061

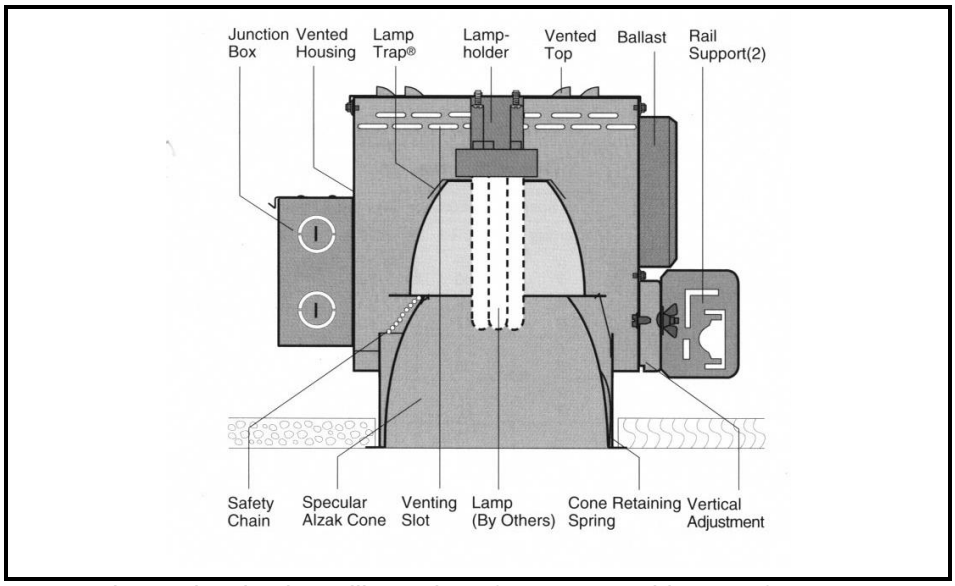
Fixture Type F3

DESCRIPTION: Recessed compact fluorescent downlight with vertical lamp, nominal 6" aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim, low-iridescent finish. Electronic ballast. Ballast shall operate all manufacturer's 26 watt lamps. Minimum recess depth 8 1/4". Maximum recess depth 10".

MANUFACTURERS: Lithonia Gotham AFV 26TRT6AR Series; Halo C6042-6001 Series; Prescolite CFT632EB Series; Kurt Versen P926; HE Williams PV60 Series.

LAMP: One CFTR26W
WATTS: 27

COMMENTS: F3A is similar except with an electronic dimming ballast.



Fixture drawing is an illustration of one acceptable manufacturer

SPARLING

111 S.W. 5TH AVE.*SUITE 1575
PORTLAND, OR 97204
PHONE: 503 / 273-0060
FAX: 503 / 273-0061

LIGHTING FIXTURE SCHEDULE

Fixture Type F4

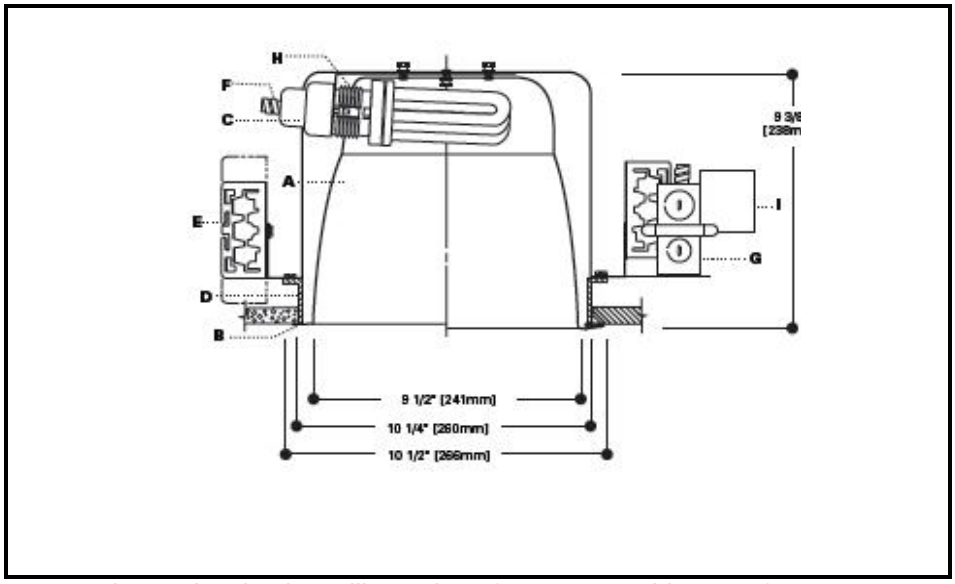
DESCRIPTION: Recessed compact fluorescent downlight with horizontal lamp, nominal 10" aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim, low-iridescent finish. Electronic dimming ballast. Ballast shall operate all manufacturer's 32 watt lamps.

MANUFACTURERS: Portfolio C9157 series; Lithonia AF series; or approved.

LAMP: Two CFTR32W

WATTS: 67

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

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PORTLAND, OR 97204
PHONE: 503 / 273-0060
FAX: 503 / 273-0061

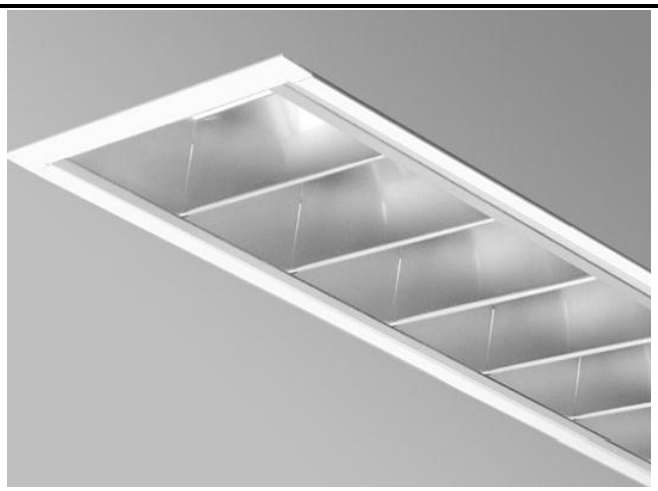
Fixture Type F5

DESCRIPTION: Recessed linear direct wall wash 4' in length with parabolic louver.

MANUFACTURERS: Pinnacle Architectural Lighting Edge E4WP Series; Litecontrol Mod2 Seriesl; Prudential P40 Series or approved.

LAMP: One F32T8
WATTS: 33

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

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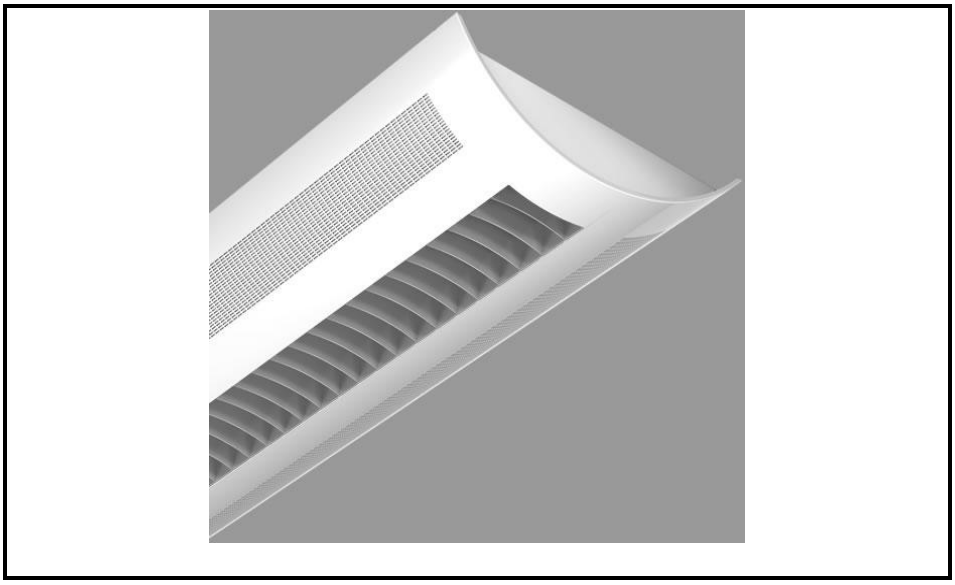
Fixture Type F6

DESCRIPTION: Pendant mounted direct/indirect fixture nominal 3 5/8" high x 10" wide. Three lamp cross section. One lamp for the down component and two lamps for the up component Steel housing with extruded mitered aluminum endcaps. Provide ballasts for switching as shown on drawings. Aircraft cable suspension with coiled cord. Mount at 10' AFF. Manufacturer's standard finish as selected by Architect. 0-10V electronic dimming ballast.

MANUFACTURERS: Focal Point Verve III series; Alera Lighting CV series; Linear Lighting C312P3 series, Litecontrol PID series or approved.

LAMP: Three F32T8/4'
WATTS: 96/4'

COMMENTS: Lengths as shown on drawings.



Fixture drawing is an illustration of one acceptable manufacturer

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PORTLAND, OR 97204
PHONE: 503 / 273-0060
FAX: 503 / 273-0061

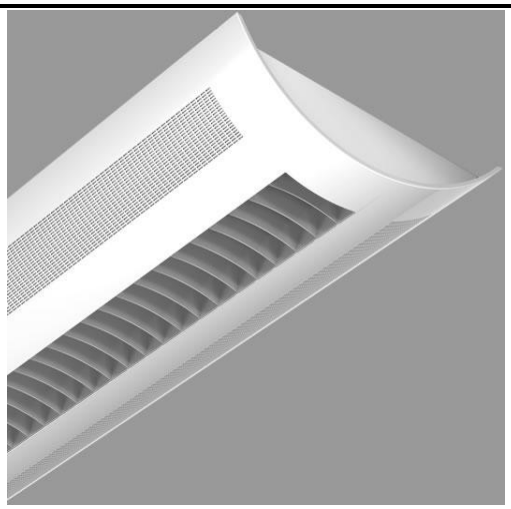
Fixture Type F6A

DESCRIPTION: Pendant mounted direct/indirect fixture nominal 3 5/8" high x 10" wide. Three lamp cross section. One lamp for the down component and two lamps for the up component Steel housing with extruded mitered aluminum endcaps. Provide ballasts for switching as shown on drawings. Aircraft cable suspension with coiled cord. Mount at 10' AFF. Manufacturer's standard finish as selected by Architect. Electronic ballast.

MANUFACTURERS: Focal Point Verve III series; Alera Lighting CV series; Linear Lighting C312P3 series, Litecontrol PID series or approved.

LAMP: Three F32T8/4'
WATTS: 96/4'

COMMENTS: Lengths as shown on drawings.
Similar to F6 except without dimming ballast.



Fixture drawing is an illustration of one acceptable manufacturer

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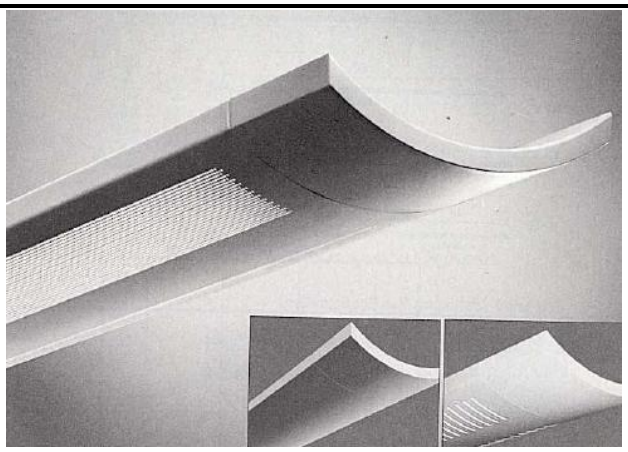
Fixture Type F7

DESCRIPTION: Pendant mounted direct/indirect fixture nominal 3 5/8" high x 10" wide. Two lamp cross section. Steel housing with extruded mitered aluminum endcaps. Provide ballasts for switching as shown on drawings. Aircraft cable suspension with coiled cord. Mount at 10' AFF. Manufacturer's standard finish as selected by Architect. Electronic ballast.

MANUFACTURERS: Focal Point Verve II series; Alera Lighting CV series; Linear Lighting C210 series; Litecontrol Acros Perf II ECSS series; Precision Luminata II LMS02 Series or approved.

LAMP: Two F32T8/4'
WATTS: 62/4'

COMMENTS: Lengths as shown on drawings.



Fixture drawing is an illustration of one acceptable manufacturer

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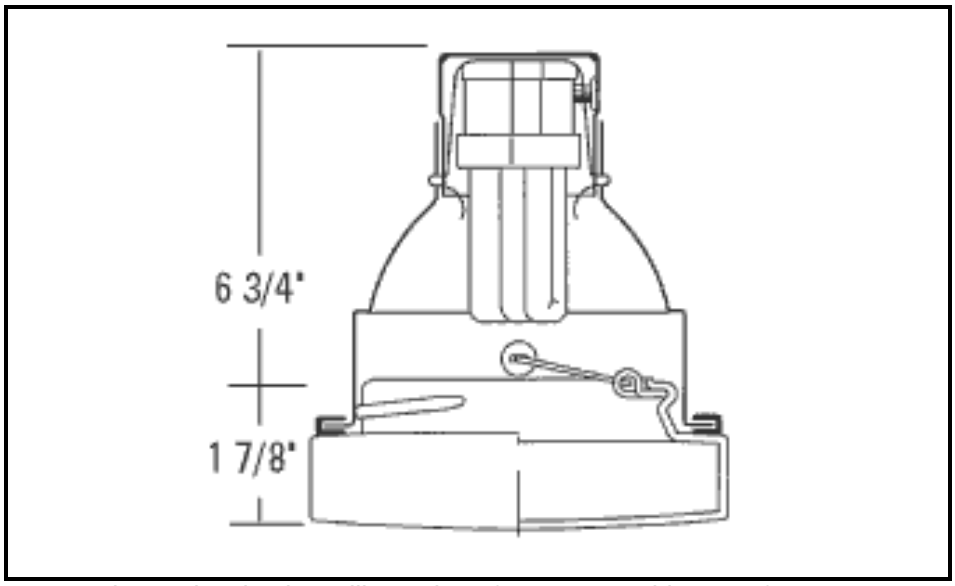
Fixture Type F8

DESCRIPTION: Recessed compact fluorescent downlight with vertical lamp and dropped opal glass lens, nominal 6" aperture. Moisture-proof gasketed housing. Electronic ballast. Maximum recess depth 7-3/4". UL listed for wet locations. Meets NEC requirements for spas and hot tubs.

MANUFACTURERS: Lightolier Lytecaster 1178SH/1100F2642U Series; Lithonia LI6F-26TRT-6LD3 Series

LAMP: One CFTR26W
WATTS: 27

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

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Fixture Type F9

DESCRIPTION: Pendant mounted, compact fluorescent fixture nominal 29" high x 10.5" diameter. Frosted Acrylic diffuser with internal aluminum reflector for downlight. Stem mounted to surface canopy to provide total standard length of 42". Spun aluminum canopy. Electronic ballast.

MANUFACTURERS: Delray Kone 6212 Series or approved equal

LAMP: Four FTT40W + One 100W Par38

WATTS: 256

COMMENTS: *Consult Architect for finish type and stem length.*

Fixture drawing is an illustration of one acceptable manufacturer

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Fixture Type F10

DESCRIPTION: Semi-recessed wall mounted adjustable uplight. Extruded aluminum housing, nominally 9-5/8" tall x 27-5/8" wide x 4" recessed x 10-3/8" deep. Electronic ballast.

MANUFACTURERS: Elliptipar 4x Style 204 Series or Sparling approved

LAMP: One FT55W/2G11
WATTS: 55

COMMENTS: *Custom color as selected by Architect.*

Fixture drawing is an illustration of one acceptable manufacturer

CANDELA
Lighting Design and Consulting

720 Olive Way * Suite 1400
Seattle, WA 98101
Phone: 206/667-0511
Fax: 206/667-0512

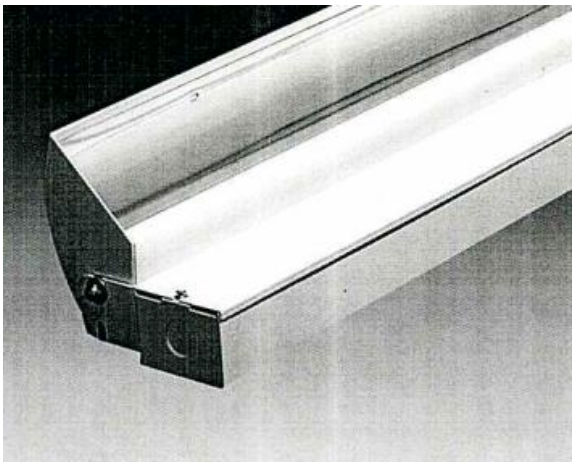
Fixture Type F11

DESCRIPTION: Directional cove fixture. Steel housing, fixture nominally 7.5" wide x 5.625" tall x 4' long. Electronic ballast. UL listed.

MANUFACTURERS: Focal Point Covelight 68Series or Sparling Approved

LAMP: One F32T8
WATTS: 31

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

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Lighting Design and Consulting

720 Olive Way * Suite 1400
Seattle, WA 98101
Phone: 206/667-0511
Fax: 206/667-0512

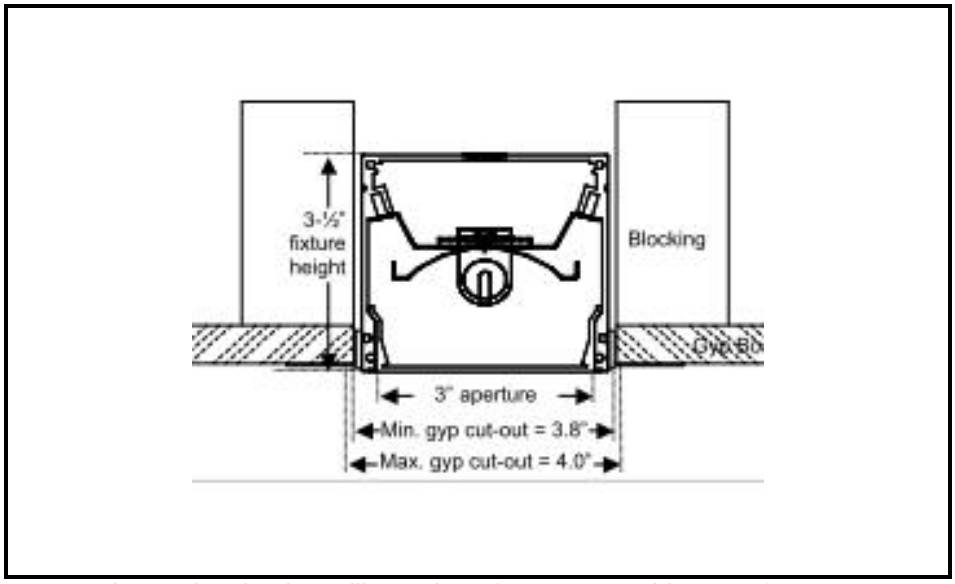
Fixture Type F12

DESCRIPTION: Direct recessed liner fixture. Extruded aluminum housing, nominally 3.5" height x 3" wide by length shown on drawing. Clear acrylic lens with gasket. Finish selected by architect.

MANUFACTURERS: Alight D5 Accolade 5 Series or Sparling approved

LAMP: One F32T8
WATTS: 31

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

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Lighting Design and Consulting

720 Olive Way * Suite 1400
Seattle, WA 98101
Phone: 206/667-0511
Fax: 206/667-0512

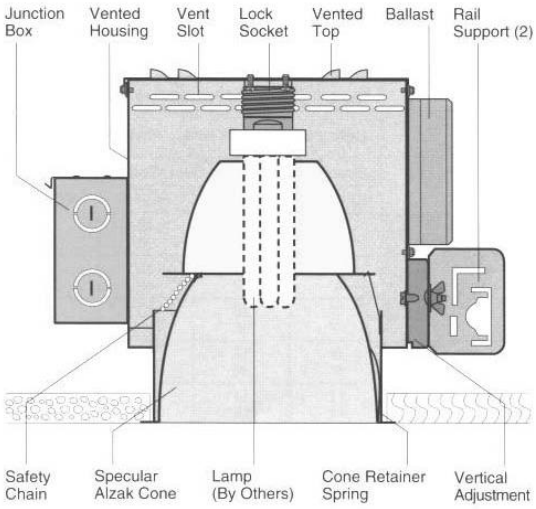
Fixture Type F13

DESCRIPTION: Recessed compact fluorescent downlight with vertical lamp, nominal 6" aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim, low-iridescent finish. Electronic ballast. Minimum recess depth 9 3/8". Maximum recess depth 10 3/16".

MANUFACTURERS: Cooper Portfolio C6042-6451 Series; Prescolite CFT642EB Series; Kurt Versen P927 Series; Omega Revelation OM642 Series.

LAMP: One 42W TTT
WATTS: 47

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

CANDELA
Lighting Design and Consulting

720 Olive Way * Suite 1400
Seattle, WA 98101
Phone: 206/667-0511
Fax: 206/667-0512

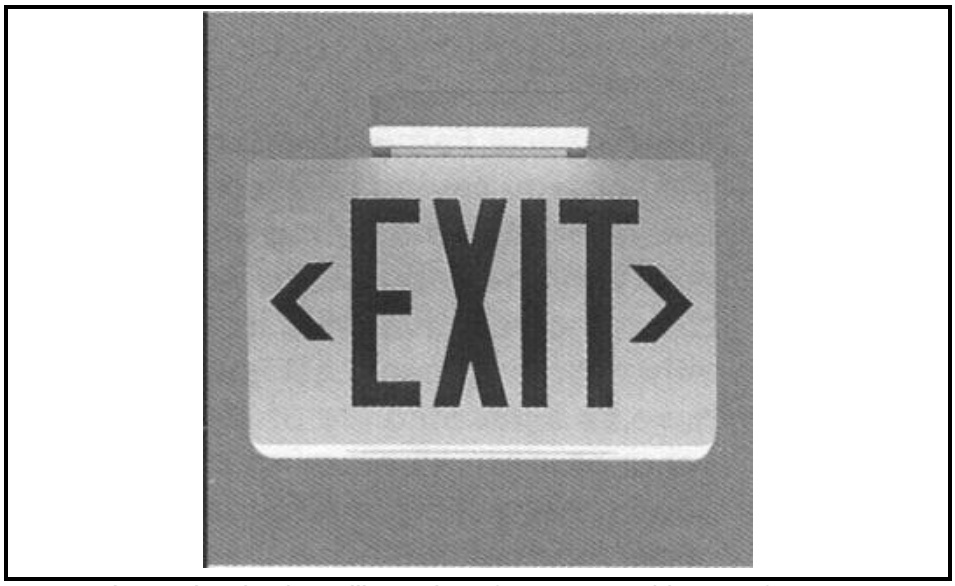
Fixture Type X1

DESCRIPTION: Single face green LED exit sign. Diecast aluminum housing, universal arrows and universal mount. Cast aluminum faceplate with stencil face, manufacturer's standard finish as selected by architect. Assembly shall be held in place within the diecast fixture frame using reinforced plastic or metallic clips. Rated lamp life shall be 20 years minimum. Shall meet UL Standard 924.

MANUFACTURERS: SureLites CX Series; Lithonia Signature Series; Dual-Lite Sempra Series; Emergi-lite Prestige Series; Chloride CXL Series; Isolite LPDC Series

LAMP: LED - Green - Supplied with fixture
WATTS: 3 maximum

COMMENTS:



Fixture drawing is an illustration of one acceptable manufacturer

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111 S.W. 5TH AVE.*SUITE 1575
PORTLAND, OR 97204
PHONE: 503 / 273-0060
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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.

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Indoor occupancy sensors

B. Related Sections include the following:
   1. Section 260519 Copper Conductors and Cables
   2. Section 262726 Wiring Devices for light switches and wall-box dimmers
   3. Section 265100 Interior Lighting and 260650.16 Lighting Fixture Schedule for light fixture ballasts
   4. Section 260942 Low Voltage Lighting Controls
   5. Section 260943 Network Lighting Controls

1.3 DEFINITIONS

A. LED: Light-Emitting Diode

B. PIR: Passive Infrared

C. DT: Dual Technology

1.4 SUBMITTALS

A. Make submittals in accordance with Section 260500 - Common Work Results For Electrical.

B. Product Data: Provide clearly marked and legible data sheets for each item of equipment being installed on the project. This shall include each major replaceable component that is part of a larger assembly. Data sheets should clearly indicate:
   1. Equipment manufacturer, make, model number, size, nameplate data, etc.
   2. Dimensional and performance data for specific unit provided as appropriate
   3. Required environmental operating parameters
   4. UL, FM and ETL listing and category
   5. Manufacturer contact information including address, telephone number, facsimile number, email address, web site address and contact person or persons.
   6. Local manufacturer’s representative contact information including address, telephone number, facsimile number, email address, web site address and contact person or persons.

C. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Lighting plan showing location, orientation, and coverage area of each sensor. This plan shall take into consideration the size and use of each space as well as the specific capabilities of submitted manufacturer's equipment to provide proper coverage to the areas of control.
   2. Interconnection diagrams showing field-installed wiring.

D. Label List: Submit list of proposed text for all labels prior to manufacturing for review and approval by Owner’s representative.

E. Warranty: Submit a copy of product warranty that complies with contract document requirements. Where these requirements exceed manufacturer’s standard warranty include cost of extended warranty in contract price.

F. Maintenance Requirements: Submit maintenance requirements manual or guidelines. This document should detail the requirements necessary to comply with the warranty. This is required for the submittal process and is in addition to the O and M requirements.

G. Samples: Provide sample devices and finishes plus other samples when requested, as part of the submittal process.

H. Commissioning Checklist: Submit a copy of the standard commissioning checklist to be utilized for this project.

1.5 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.6 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturer shall have been in the business of manufacturing and providing service for lighting control equipment for similar capabilities and size, under the same name and ownership, for a minimum of three years preceding bid date of the project.
   2. All components and assemblies shall be factory pre-tested prior to installation.
   3. Factory trained technicians shall be on site for start-up, commissioning and training.
   4. Factory trained technicians shall be available for telephone support twenty four (24) hours a day, seven (7) days a week.

B. Regulatory Requirements
   1. Underwriters Laboratories: Provide U.L. listed lighting control equipment.
   2. Code of Federal Regulations: 47 CFR - FCC All assemblies are to be in compliance with FCC emissions standards specified in Part 15 for Class A application.

1.7 WARRANTY

A. Manufacturer's Warranty: The manufacturer shall provide a written warranty agreeing to provide parts to replace any portion of the lighting control system equipment that fails due to material or workmanship for a period of twelve months from warranty commencement.

B. Warranty Commencement: Warranty shall begin at the point of substantial completion of the system installation, which is defined as the date when commissioning and owner training has been completed and the owner obtains beneficial use of the system.

C. Warranty Replacement Parts: The manufacturer shall be able to ship replacement parts within 24 hours for any component that that fails due to material or workmanship during the warranty period.

PART 2 PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

A. Subject to compliance with the contract documents, provide products from one of the following manufacturers:
   1. Greengate (Cooper Controls)
   2. Hubble
   3. Leviton
   4. Lutron
   5. Novitas, Inc.
   6. Sensor Switch
   7. Wattstopper

B. General Operation
   1. The Occupancy Sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the loads automatically. Sensors shall turn on the load within 2 feet of entrance and shall not initiate "on" outside of entrance.
   2. Upon detection of human activity by the detector, a Time Delay shall be initiated to maintain the light on for a field adjustable pre-set period.
   3. Mounting
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay (when required): Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
      c. Time Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   4. Line Voltage Sensors
      a. Sensor shall be a self-contained dual voltage device capable of directly switching loads upon detection of human activity.

b. Sensor must be rated for 800 watts at 120 VAC, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/6 hp motors or rated for 1000 watts at 277 VAC, suitable for fluorescent light fixtures with magnetic or electronic ballasts, or 1/3 hp motors minimum. Sensor shall be capable of parallel wiring for 3-way switching applications.
c. Sensor Time Delay shall be factory set for typical applications, and field adjusted during commissioning. Sensor must provide a LED motion indicator.

5. Low Voltage Sensor
a. Sensors must be designed to work in conjunction with remote power packs, relays, or other control systems. Sensors must operate with a Class 2, low voltage wiring strategy. Sensors must be capable of being parallel wired for multi-sensor applications.
b. Sensor must provide a transistor output, returning the voltage input rectified to DC, to control remote power packs, relays, or other control systems. Sensor must have optional single pole, double throw signal relay capable of being wired open on occupancy, or closed on occupancySensor Time Delay shall be factory set for typical applications, and field adjusted during commissioning. Sensor must provide a LED motion indicator.

C. Switch-Box Occupancy Sensors
1. General
a. Sensor must not protrude out from the cover plate more than 0.37 inches, and recess into the switch box more than 1 inch. Sensor must surface mount to single gang switch box, and accept accessory plates for multi-gang installations. Sensor must provide an Off/Auto override switch, (2 switches if 2-pole device).
b. Manual or Auto ON configurable.
c. Optional 2-Pole units must be available. Manual or Auto ON shall be configurable for both poles.
d. Shall be provided for single stall restrooms less than 200 sq. feet.
2. Passive Infrared (PIR) Technology
a. PIR sensing, incorporating a combination of heat and movement sensing to detect occupancy in the area of coverage.

D. Ceiling Occupancy Sensors
1. General
a. Sensor shall be ceiling mounted device, mounted to either a single gang enclosure, or surface mounted to a round surface raceway pancake box.
b. Time delay shall be set during commissioning and field adjustable.
2. Passive Infrared (PIR) Technology
a. PIR sensing, incorporating a combination of heat and movement sensing to detect occupancy in the area of coverage.
b. PIR sensing must utilize a high density Fresnel domed lens, providing a circular view pattern of 360 degrees.
c. PIR Technology shall be utilized for private offices less than 200 sq. feet.
3. Dual Technology (DT)
a. Sensing must incorporate PIR with Ultrasonic. Both PIR and Ultrasonic motion sensing shall initiate an ON condition and either technology sending motion shall keep the ON state.
1) Either technology shall be able to be disabled during commissioning if necessary for the specific application.
2) Ultrasonic
a) Ultrasonic sensing incorporating an omni-directional Doppler technology to detect occupancy in the area of coverage.
4. Dual Technology shall be utilized for conference rooms, classrooms, multi-stall restrooms, and spaces larger than 200 sq. feet.

2.2 POWER PACKS AND SLAVE PACKS

A. Manufacturer: Same as 2.2 A.

B. Power Packs and Slave Packs must be designed to power and accept signals from remote Low Voltage Sensors, or other control devices, and directly switch the line voltage of the desired load controlled.

C. Power Packs must accept 120, 240, or 277 VAC utilizing a dual tap transformer.

D. Power Pack and Slave Pack relay switching shall not require more than 3 milliamps of current at 15 to 30 VDC.

E. Power Pack and Slave Pack relay switching shall be performed with a mechanical relay in parallel with an AC Semiconductor to allow relay contacts to switch under a no load condition. Switching capacity shall be 20 amps of all types of loads: Incandescent, Electronic Ballast, Magnetic, or Motor.

F. Power Packs shall be available in combination 2-Pole units capable of switching two independent loads, 20 amps each.

G. Power Packs shall be provided with

2.3 MULTIPOLE CONTACTORS

A. Manufacturer: Subject to compliance with the contract documents, provide products from one of the following manufacturers
1. ASCO Power Technologies
2. Eaton Electrical, Inc.
3. GE Industrial Systems
4. Hubbell Lighting
5. Lithonia Lighting
6. Square D
7. Tork
8. Touch-Plate, Inc.
9. Wattstopper

B. Description: Electrically operated and mechanically or electrically held (as noted on the drawings), complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballasts (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Control-Coil Voltage: Match low voltage lighting control power source.
3. Enclosure: Indoor NEMA 1 or as indicated on the drawings.

2.4 CONTROL RELAYS

A. Industrial Control Relays: Rated 600V, 20A convertible contacts. Square D Class 8501 XMO series.

B. General Purpose Relays: Rated 120/ 240 volt, 10A. Square D Class 8501 Type K plug in series with screw terminal socket.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Section 260519 - Conductors and Cables.

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 22 AWG, complying with Section 260519 - Copper Conductors and Cables.

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Section 260519 - Copper Conductors and Cables.

D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 260519 - Copper Conductors and Cables.

PART 3 EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Install sensors in accordance with manufacturer's instructions. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 - Copper Conductors and Cables.

B. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 - Identification For Electrical Systems.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with manufacturers' commissioning checklist and section 260126 Maintenance and Testing of Electrical Systems.
   2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 SYSTEM STARTUP

A. System startup shall take place prior to demonstration of system to Owner. After the system has been installed the Contractor shall provide manufacturer’s recommended commissioning with factory trained and authorized technicians on-site, to:
   1. Verify that the contractor has properly installed and interconnected all necessary components.
   2. Verify correct operation of all system components.
   3. Verify that all switch and contact inputs are in compliance with contract requirements.
   4. Aim and adjust all occupancy sensors for proper operation.
   5. Submit completed verification checklist.

3.6 OWNER’S INSTRUCTIONS AND SYSTEM DEMONSTRATION

A. System Demonstration
   1. Schedule demonstration a minimum of two-weeks prior to system turn over and substantial completion. Schedule with owner’s representative and electrical engineer.
   2. Demonstrate complete system operation and contract compliance to designated owner’s representative and engineer to prove system is functional and ready for comprehensive training.

B. System Instruction
   1. The Contractor shall after one week (minimum) written notification to Architect conduct an instruction session during which all maintenance and operational aspects of the system will be described and demonstrated to personnel selected by the Owner. The session shall be conducted by a Contractor's representative thoroughly familiar with the characteristics of the system. O and M manual information regarding the system shall be turned over to the Architect prior to scheduling the instruction session.
   2. Training shall utilize the following draft documents:
      a. Draft O and M Manual
      b. Contractor’s record drawings
   3. The training effort shall validate the O and M Manual and record drawing documentation.

END OF SECTION

PANELBOARD SCHEDULES

PART 1 GENERAL

1.1 DESCRIPTION

A. Panel schedules attached herein.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

Sparling

Name: **EL1LA** 120/208V 3Ø 4W 100A Main lugs only

Location: ELEC ROOM 113A Surface Mounted

Serves: EMERGENCY - FIRST FLOOR + BASEMENT Single Lugs

Panel Type: Panelboard 22,000 AIC 6" Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Recept TELECOM RM. 143B	0.36	20/1 CB	•	20/1 CB	1.30	Lighting SOUTH CORRIDOR/VESTIBULES BASEMEN	2†
3†	Recept TELECOM RM. 113E	0.36	20/1 CB	•	20/1 CB	0.87	Lighting WEST CORRIDOR BASEMENT	4†
5†	Equip LCP CK T1	0.50	20/1 CB	•	20/1 CB	1.98	Lighting NORTH CORRIDOR/VESTIBULES BASEMEI	6†
7†	Equip ETHERNET INTERFACE MODULE	0.10	20/1 CB	•	20/1 CB	0.92	Lighting SOUTH CORRIDOR/VESTIBULES 1ST FLOO	8†
9†	Lighting EXTERIOR	0.30	20/1 CB	•	20/1 CB	1.34	Lighting WEST CORRIDOR 1ST FLOOR	10†
11	Lighting LOWER LOBBY BROADWAY TOWER	0.77	20/1 CB	•	20/1 CB	1.43	Lighting NORTH CORRIDOR/VESTIBULES 1ST FLOC	12†
13	Spare	0.00	20/1 CB	•	20/1 CB	0.12	Lighting ELEC ROOM 113A	14†
15	Spare	0.00	20/1 CB	•	20/1 CB	0.31	Lighting RESTROOMS	16†
17	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	18
19	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	20
21	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	22
23	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	24
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42

Rev:
Revised circuits marked ‡ Existing circuits marked †
Project #: B14926
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	ØA	ØB	ØC
Connected KVA	2.81	3.18	4.68

* Circuit Breaker Code
G = GFCI H= HID Rated
S = Shunt Trip C = HACR Rated
D= Switching Duty # = see note
A = AFCI

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	9.35	x 100%	9.35	26	x 125%	32
Recept	0.72	10 KVA @ 100%, rest @ 50%	0.72	2	x 100%	2
Equip	0.60	x 100%	0.60	2	x 100%	2
	10.67	30 Amps	10.67	30		36

Sparling

Name: EL2LA
Location: ELECTRICAL ROOM 213A
Serves: EMERGENCY-SECOND FLOOR

120/208V 3Ø 4W
100A Main lugs only
Surface Mounted
Single Lugs

Panel
Type: Panelboard
22,000 AIC
6" Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Recept TELECOM RM. 213E	0.36	20/1 CB	•	20/1 CB	1.91	Lighting SOUTH CORRIDOR - 2ND FLOOR	2†
3†	Recept TELECOM RM. 243B	0.36	20/1 CB	•	20/1 CB	1.74	Lighting NORTH CORRIDOR - 2ND FLOOR	4†
5†	Equip LCP CK T2	0.50	20/1 CB	•	20/1 CB	0.40	Lighting NORTH LIGHTWELL	6†
7†	Equip ETHERNET INTERFACE MODULE	0.10	20/1 CB	•	20/1 CB	0.40	Lighting SOUTH LIGHTWELL	8†
9	Spare	0.00	20/1 CB	•	20/1 CB	0.12	Lighting ELECTRICAL ROOM 213A	10†
11	Spare	0.00	20/1 CB	•	20/1 CB	0.58	Lighting EAST CORRIDOR - 2ND FLOOR	12
13	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	14
15	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	16
17	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	18
19	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	20
21	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	22
23	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	24
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42

Rev:
Revised circuits marked ‡ Existing circuits marked †
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	ØA	ØB	ØC
Connected KVA	2.76	2.22	1.47

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	5.14	x 100%	5.14	14	x 125%	18
Recept	0.72	10 KVA @ 100%, rest @ 50%	0.72	2	x 100%	2
Equip	0.60	x 100%	0.60	2	x 100%	2
	6.46	18 Amps	6.46	18		21

Sparling
Name: **L1LA** 120/208V 3Ø 4W 100A Main lugs only
Location: ELEC. RM. 113A Surface Mounted
Serves: LIGHTING-SOUTH Feed Thru Lugs

Panel
Type: Panelboard
22,000 AIC
Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Lighting ACTING STUDIO 121	1.12	20/1 CB	•	20/1 CB	1.20	Lighting SOUTH CORRIDOR/VESTIBULES BASEMEN	2†
3†	Lighting ACTING STUDIO 121 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	1.12	Lighting WEST CORRIDOR BASEMENT	4†
5†	Lighting STAGE STORAGE/TELEPHONE	1.40	20/1 CB	•	20/1 CB	0.92	Lighting NORTH CORRIDOR/VESTIBULES BASEMEN	6†
7†	Lighting RESTROOMS/TICKET BOOTH/FACULTY 12	1.11	20/1 CB	•	20/1 CB	0.90	Lighting SOUTH CORRIDOR/VESTIBULES 1ST FLOO	8†
9†	Lighting ACTING STUDIO 119	1.49	20/1 CB	•	20/1 CB	1.67	Lighting WEST CORRIDOR 1ST FLOOR	10†
11†	Lighting ACTING STUDIO 119 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	1.18	Lighting NORTH CORRIDOR/VESTIBULES 1ST FLOC	12†
13†	Lighting SCENE SHOP 101	0.87	20/1 CB	•	20/1 CB	1.42	Lighting BROADWAY LOBBY - BASEMENT	14
15†	Lighting SCENE SHOP 103	1.08	20/1 CB	•	20/1 CB	0.65	Lighting BROADWAY CANOPY	16
17†	Lighting GREEN ROOM 115D/DRESSING ROOMS 11	1.00	20/1 CB	•	20/1 CB	1.30	Lighting PIANO LAB 135	18†
19	Spare	0.00	20/1 CB	•	20/1	0.20	Lighting PIANO LAB 135 - LV CONTROL BOX	20†
21	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	22
23	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	24
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42

Rev:
Revised circuits marked ‡ Existing circuits marked †
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	ØA	ØB	ØC
Connected KVA	6.81	6.19	6.00

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	19.00	x 100%	19.00	53	x 125%	66
	19.00	53 Amps	19.00	53		66

Sparling
Name: **L1LB** 120/208V 3Ø 4W 100A Main lugs only
Location: ELEC. RM. 143F Surface Mounted
Serves: LIGHTING-NORTH Feed Thru Lugs

Panel
Type: Panelboard
22,000 AIC
Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Lighting DRESSING ROOMS 149F/GREEN ROOM 149	1.82	20/1 CB	•	20/1 CB	0.00	Spare	2
3†	Lighting DRESSING ROOM 149A	1.39	20/1 CB	•	20/1 CB	0.00	Spare	4
5†	Lighting TH FACULTY/CONFERENCE/STORAGE	2.08	20/1 CB	•	20/1 CB	0.00	Spare	6
7†	Lighting TH FACULTY DEPT 127	1.30	20/1 CB	•	20/1 CB	0.00	Spare	8
9	Lighting FIRST FLOOR BROADWAY TOWER	0.81	20/1 CB	•	20/1 CB	0.00	Spare	10
11	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	12
13	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	14
15	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	16
17	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	18
19	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	20
21	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	22
23	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	24
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42

Rev:
Revised circuits marked ‡ Existing circuits marked †
Project #: B14926
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	ØA	ØB	ØC
Connected KVA	3.12	2.20	2.08

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	7.40	x 100%	7.40	21	x 125%	26
	7.40	21 Amps	7.40	21		26

Sparling

Name: **L1NA1** 120/208V 3Ø 4W 225A Main CB

Location: ELECTRICAL ROOM 143F Surface Mounted

Serves: RECEPTACLES AND EQUIPMENT - NORTH Feed Thru Lugs

Panel Type: Panelboard 22,000 AIC Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1	Spare	0.00	20/1 CB	•	20/1 CB	0.36	Recept TELECOM RM. 143B	2†
3	Spare	0.00	20/1 CB	•	20/1 CB	0.36	Recept TELECOM RM. 143B	4†
5	Spare	0.00	20/1 CB	•	20/1 CB	0.36	Recept TELECOM RM. 143B	6†
7†	Misc HAND DRYER	1.50	20/1 CB	•	20/1 CB	0.00	Spare	8
9†	Recept STAR DRESSING 149F - MAKEUP STATION	0.30	20/1 CB	•	20/1 CB	0.20	Misc DDC PANEL	10†
11†	Recept STAR DRESSING 149F - MAKEUP STATION	0.30	20/1 CB	•	20/1 CB	0.00	Spare	12
13†	Recept DRESSING 149J - MAKEUP STATION	0.30	20/1 CB	•	20/1 CB	0.00	Spare	14
15†	Recept DRESSING 149J - MAKEUP STATION	0.30	20/1 CB	•	20/1 CB	0.00	Spare	16
17†	Recept DRESSING 149J - MAKEUP STATION	0.30	20/1 CB	•	20/1 CB	0.00	Spare	18
19†	Recept DRESSING 149J - MAKEUP STATION	0.30	20/1 CB	•	20/1 CB	0.00	Spare	20
21†	Recept DRESSING 149J - MAKEUP STATION	0.30	20/1 CB	•	20/1 CB	0.00	Spare	22
23†	Recept DRESSING 149J, TOILET 149G	0.90	20/1 CB	•	20/1 CB	0.00	Spare	24
25†	Recept GREEN ROOM 155	0.90	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Recept STAGE/BACKSTAGE 161	0.72	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/2 CB	•	20/1 CB	0.00	Spare	36
37	-------	0.00	------- ---	•	20/3	0.00	Spare	38
39	Spare	0.00	30/2 CB	•	------- ---	0.00	-------	40
41	-------	0.00	------- ---	•	------- ---	0.00	-------	42

Rev:
Revised circuits marked ‡ Existing circuits marked †

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	ØA	ØB	ØC
Connected KVA	3.36	2.18	1.86

* Circuit Breaker Code

G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Recept	21.94	10 KVA @ 100%, rest @ 50%	15.97	44	x 100%	44
Misc	1.70	x 100%	1.70	5	x 100%	5
	23.64	66 Amps	17.67	49		49

Sparling

Name: **L1NA2** 120/208V 3Ø 4W 225A Main lugs only

Location: ELEC. RM. 143F Surface Mounted

Serves: RECEPTACLES AND EQUIPMENT - NORTH Single Lugs

Panel Type: Panelboard 22,000 AIC Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Recept TH. FAC. RMS. 145A, B, DRESS. RM. 149A	0.90	20/1 CB	•	20/1 CB	1.08	Recept DRESSING RMS. 149A, F	2†
3†	Recept TH. FAC. RMS. 145A, B, DRESS. RM. 149A	0.90	20/1 CB	•	20/1 CB	0.00	Spare	4
5†	Recept TH. FAC. RMS. 145A, B, DRESS. RM. 149A	0.90	20/1 CB	•	20/1 CB	1.08	Recept DRESSING RMS. 149A, F	6†
7†	Recept PIANO LAB, TH. FAC	0.90	20/1 CB	•	20/1 CB	0.90	Recept THEATRE FACILTY RMS. 127, 131	8†
9†	Recept PIANO LAB, TH. FAC	0.90	20/1 CB	•	20/1 CB	0.90	Recept THEATRE FACILTY RMS. 127, 131	10†
11†	Recept PIANO LAB - PODIUM	0.36	20/1 CB	•	20/1 CB	0.60	Recept THEATRE FACILTY RMS. 127, 131	12†
13†	Recept FACULTY 143B,C,D.E	0.54	20/1 CB	•	20/1 CB	0.54	Recept THEATRE FACILTY RM. 127	14†
15†	Recept FACULTY 143B,C,D.E	0.54	20/1 CB	•	20/1 CB	0.54	Recept THEATRE FACILTY RM. 127	16†
17†	Recept FACULTY 143B,C,D.E	0.54	20/1 CB	•	20/1 CB	0.36	Recept THEATRE FACILTY RM. 127	18†
19†	Recept TICKET BOOTH 120	0.80	20/1 CB	•	20/1 CB	1.08	Recept PIANO LAB - MOA	20†
21†	Recept TICKET BOOTH 120	0.80	20/1 CB	•	20/1 CB	1.08	Recept PIANO LAB - MOA	22†
23	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	24
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/2 CB	•	20/1 CB	0.00	Spare	36
37	-------	0.00	------- ---	•	20/3 CB	0.00	Spare	38
39	Spare	0.00	30/2 CB	•	------- —	0.00	-------	40
41	-------	0.00	------- ---	•	------- —	0.00	-------	42

	ØA	ØB	ØC
Connected KVA	6.74	5.66	3.84

Rev:
Revised circuits marked ‡ Existing circuits marked †

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* Circuit Breaker Code

G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Recept	16.24	10 KVA @ 100%, rest @ 50%	13.12	36	x 100%	36
	16.24	45 Amps	13.12	36		36

Sparling
Name: **L2LA** 120/208V 3Ø 4W 100A Main CB
Location: ELEC. RM. 213A Surface Mounted
Serves: LIGHTING-SOUTH Feed Thru Lugs

Panel
Type: Panelboard
22,000 AIC
Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Lighting MIDI LAB- LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	1.88	Lighting SOUTH CORRIDOR - 2ND FLOOR	2†
3†	Lighting DESIGN STUDIO MAKE-UP/MIDI LAB	1.86	20/1 CB	•	20/1 CB	1.71	Lighting NORTH, EAST CORRIDOR - 2ND FLOOR	4†
5†	Lighting DESIGN STUDIO - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	1.30	Lighting CLASSROOM 249	6†
7†	Lighting M STUDENT LOUNGE	0.93	20/1 CB	•	20/1 CB	0.20	Lighting CLASSROOM 249 - LV CONTROL BOX	8†
9†	Lighting M STUDENT LOUNGE - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	1.30	Lighting CLASSROOM 247	10†
11†	Lighting JAN/TEL/FACULTY/M T/S/M FACULTY 2(	1.74	20/1 CB	•	20/1 CB	0.20	Lighting CLASSROOM 247 - LV CONTROL BOX	12†
13†	Lighting MUSIC CR 219	1.30	20/1 CB	•	20/1 CB	1.30	Lighting M PRACTICE ROOMS	14†
15†	Lighting MUSIC CR 219 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	0.20	Lighting M PRACTICE ROOMS - LV CONTROL BOX	16†
17†	Lighting MUSIC CR 221	1.49	20/1 CB	•	20/1 CB	0.96	Lighting MTS PIANO 201	18†
19†	Lighting MUSIC CR 221 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	0.20	Lighting MTS PIANO 201 - LV CONTROL BOX	20†
21†	Lighting MUSIC CR 225	1.67	20/1 CB	•	20/1 CB	1.11	Lighting FAC OFFICES 2ND FLOOR BROADWAY TOV	22
23†	Lighting MUSIC CR 225 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	1.09	Lighting 2ND FLOOR BROADWAY TOWER	24
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42

Rev:
Revised circuits marked ‡ Existing circuits marked †
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	ØA	ØB	ØC
Connected KVA	6.21	8.26	7.19

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	21.65	x 100%	21.65	60	x 125%	75
	21.65 60 Amps		21.65	60		75

Sparling
Name: **L2NA1** 120/208V 3Ø 4W 225A Main CB
Location: ELEC. RM. 243F Surface Mounted
Serves: RECEPTACLES AND EQUIPMENT - NORTH Feed Thru Lugs

Panel
Type: Panelboard
22,000 AIC
Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Recept MUSIC CLASSRM. 245C, M. T/S	0.72	20/1 CB	•	20/1 CB	0.00	Spare	2
3†	Recept MUSIC CLASSRM. 245C, M. T/S	0.72	20/1 CB	•	20/1 CB	0.00	Spare	4
5†	Recept MUSIC CLASSRM. 245C, M. T/S	0.72	20/1 CB	•	20/1 CB	0.00	Spare	6
7†	Recept M. T/S, M. FACIILTY	0.72	20/1 CB	•	20/1 CB	0.54	Recept CLASSRM. 247	8†
9†	Recept M. T/S, M. FACIILTY	0.72	20/1 CB	•	20/1 CB	0.36	Recept CLASSRM. 247 - PODIUM	10†
11†	Recept M. T/S, M. FACIILTY	0.72	20/1 CB	•	20/1 CB	0.54	Recept CLASSRM. 247	12†
13†	Recept M. T/S	0.72	20/1 CB	•	20/1 CB	0.54	Recept MUSIC LISTEN. 248, CORRIDOR	14†
15†	Recept M. T/S	0.72	20/1 CB	•	20/1 CB	0.54	Recept MUSIC LISTEN. 248, CORRIDOR	16†
17†	Recept M. T/S	0.72	20/1 CB	•	20/1 CB	0.72	Recept MUSIC LISTEN. 248, CORRIDOR	18†
19†	Recept FAC OFFICE 249A	0.90	20/1 CB	•	20/1 CB	0.70	Equip STORAGE 249F - RADIANT HEAT PUMP	20†
21†	Recept FAC OFFICE 249B	0.72	20/1 CB	•	20/1 CB	0.00	Spare	22
23†	Recept FAC OFFICE 249C	1.08	20/1 CB	•	20/1 CB	0.00	Spare	24
25†	Recept FAC OFFICE 249D	0.90	20/1 CB	•	20/1 CB	0.00	Spare	26
27†	Recept FAC OFFICE 249D, DANCE 255	0.90	20/1 CB	•	20/1 CB	0.00	Spare	28
29†	Recept HALLWAY C202, DANCE 255	0.72	20/1 CB	•	20/1 CB	0.00	Spare	30
31†	Recept M FAC 200B, DIMMER ROOM 275C	0.72	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/2 CB	•	20/1 CB	0.00	Spare	36
37	-------	0.00	------- ---	•	20/3 CB	0.00	Spare	38
39	Spare	0.00	30/2 CB	•	------- ---	0.00	-------	40
41	-------	0.00	------- ---	•	------- ---	0.00	-------	42

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Revised circuits marked ‡ Existing circuits marked †
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	ØA	ØB	ØC
Connected KVA	6.46	4.68	5.22

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Recept	29.72	10 KVA @ 100%, rest @ 50%	19.86	55	x 100%	55
Equip	0.70	x 100%	0.70	2	x 100%	2
	30.41	84 Amps	20.56	57		57

Sparling
Name: **L2NA2** 120/208V 3Ø 4W 225A Main lugs only
Location: ELEC. RM. 243F Surface Mounted
Serves: RECEPTACLES AND EQUIPMENT - NORTH Feed Thru Lugs

Panel
Type: Panelboard
22,000 AIC
Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept M. T/S RM. 237B, M. FACIITY RMS. 237A, C	2†
3	Spare	0.00	20/1 CB	•	20/1 CB	0.54	Recept M. T/S RM. 237B, M. FACIITY RMS. 237A, C	4†
5	Spare	0.00	20/1 CB	•	20/1 CB	0.54	Recept M. T/S RM. 237B, M. FACIITY RMS. 237A, C	6†
7	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231, A, B	8†
9	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231, A, B	10†
11	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231, A, B	12†
13	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231C, G	14†
15	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231C, G	16†
17	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231C, G	18†
19	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231D, E, F	20†
21	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231D, E, F	22†
23	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept MUSIC DEPARTMENT RMS. 231D, E, F	24†
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/2 CB	•	20/1 CB	0.00	Spare	36
37	-------	0.00	------- ---	•	20/3 CB	0.00	Spare	38
39	Spare	0.00	30/2 CB	•	------- ---	0.00	-------	40
41	-------	0.00	------- ---	•	------- ---	0.00	-------	42

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	ØA	ØB	ØC
Connected KVA	2.88	2.70	2.70

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Recept	14.06	10 KVA @ 100%, rest @ 50%	12.03	33	x 100%	33
	14.06	39 Amps	12.03	33		33

Sparling
Name: **L3LB**
Location: ELEC. RM. 343F
Serves: LIGHTING-NORTH

120/208V 3Ø 4W
100A Main CB
Surface Mounted
Single Lugs

Panel
Type: Panelboard
22,000 AIC
Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Lighting OFFICES 349 / WORK ROOM / RESTROOM	1.74	20/1 CB	•	20/1 CB	0.70	Lighting ATTIC	2†
3†	Lighting GALLERY 349	0.93	20/1 CB	•	20/1 CB	0.70	Lighting ATTIC	4†
5	Lighting 3RD FLOOR BROADWAY TOWER	0.80	20/1 CB	•	20/1 CB	0.00	Spare	6
7†	Lighting M T/S 345 / M FAC 343 / STORAGE RMS	1.36	20/1 CB	•	20/1 CB	0.00	Spare	8
9†	Lighting CLASSROOM 339	1.49	20/1 CB	•	20/1 CB	0.00	Spare	10
11†	Lighting CLASSROOM 339 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	0.00	Spare	12
13†	Lighting MUSIC CR 337	1.12	20/1 CB	•	20/1 CB	0.00	Spare	14
15†	Lighting MUSIC CR 337 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	0.00	Spare	16
17†	Lighting MUSIC CR 335	1.30	20/1 CB	•	20/1 CB	0.00	Spare	18
19†	Lighting MUSIC CR 335 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	0.00	Spare	20
21†	Lighting FILM LECTURE 331	1.67	20/1 CB	•	20/1 CB	0.00	Spare	22
23†	Lighting FILM LECTURE 331 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	0.00	Spare	24
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42

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	ØA	ØB	ØC
Connected KVA	5.12	4.99	2.50

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	12.61	x 100%	12.61	35	x 125%	44
	12.61 35 Amps		12.61	35		44

Sparling
Name: **LBLB** 120/208V 3Ø 4W 100A Main CB
Location: ELEC. ROOM 43G Surface Mounted
Serves: LIGHTING-NORTH Feed Thru Lugs

Panel
Type: Panelboard
22,000 AIC
Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Lighting BAND STORAGE/TEL 43B/M LIBRARY/ELE	1.42	20/1 CB	•	20/1 CB	0.00	Spare	2
3†	Lighting BAND ROOM	1.80	20/1 CB	•	20/1 CB	0.00	Spare	4
5†	Lighting PERCUSSION REHERSAL	1.30	20/1 CB	•	20/1 CB	1.92	Lighting SUB BASEMENT - THEATER STORAGE	6†
7†	Lighting PERCUSSION REHERSAL - LV CONTROL BC	0.20	20/1 CB	•	20/1 CB	1.62	Lighting ROOMS 25,B,C,D,E,G	8†
9†	Lighting INSTRUMENTAL STORAGE	1.12	20/1 CB	•	20/1 CB	0.00	Spare	10
11†	Lighting MTS/PERCUSSION STORAGE	0.74	20/1 CB	•	20/1 CB	0.00	Spare	12
13†	Lighting BRASS REHEARSAL/PRACTICE ROOMS	1.80	20/1 CB	•	20/1 CB	0.00	Spare	14
15†	Lighting MEP	0.62	20/1 CB	•	20/1 CB	0.00	Spare	16
17†	Lighting COSTUME CRAFT SHOP/JAN SUPPLY	1.55	20/1 CB	•	20/1 CB	0.00	Spare	18
19†	Lighting ACTING STUDIO 11	1.05	20/1 CB	•	20/1 CB	0.00	Spare	20
21†	Lighting ACTING STUDIO 7 / COSTUME SHOP 5A	1.56	20/1 CB	•	20/1 CB	0.00	Spare	22
23†	Lighting COSTUME STORAGE	1.18	20/1 CB	•	20/1 CB	0.00	Spare	24
25†	Lighting PRACTICE ROOMS	0.72	20/1 CB	•	20/1 CB	0.00	Spare	26
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28
29†	Lighting JAZZ REHEARSAL 47	1.30	20/1 CB	•	20/1 CB	0.00	Spare	30
31†	Lighting JAZZ REHEARSAL 47 - LV CONTROL BOX	0.20	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42

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	ØA	ØB	ØC
Connected KVA	7.01	5.09	8.00

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	20.10	x 100%	20.10	56	x 125%	70
	20.10	56 Amps	20.10	56		70

Sparling

Name: **LSBNA1** 120/208V 3Ø 4W 100A Main lugs only

Location: EQUIPMENT ROOM 55C Surface Mounted

Serves: RECEPTACLES AND EQUIPMENT - SUB BASI Single Lugs

Panel Type: Panelboard 22,000 AIC Deep

#	Description	Load	CB *	A B C	CB *	Load	Description	#
1†	Recept THEATRE STORAGE	0.72	20/1 CB	•	20/1 CB	0.50	Misc PROJECTION SCREEN - ROOM 75S	2†
3†	Recept EQUIPMENT, FAN ROOM	0.72	20/1 CB	•	20/1 CB	0.18	Misc FA PRINTER - ROOM 55C	4†
5†	Recept EQUIPMENT, FAN ROOM	0.72	20/1 CB	•	20/1 CB	0.80	Recept ROOM 55	6†
7†	Recept VEST., RECORDING	0.72	20/1 CB	•	20/1 CB	0.80	Recept ROOM 55	8†
9†	Recept MEP #55E	0.72	20/1 CB	•	20/1 CB	0.72	Recept DRESSING ROOMS - 55L / 55K	10†
11†	Recept MEP #55E	0.72	20/1 CB	•	20/1 CB	0.72	Recept DRESSING ROOM PLUG MOLD	12†
13†	Recept VESTIBULES 75E	0.80	20/1 CB	•	20/1 CB	0.72	Recept DRESSING ROOM PLUG MOLD	14†
15	Spare	0.00	20/1 CB	•	20/1 CB	0.54	Recept DRESSING ROOM PLUG MOLD	16†
17	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept DRESSING ROOM PLUG MOLD	18†
19†	Lighting DRESSING RM / GREEN RM / PLUMBING F	1.91	20/1 CB	•	20/1 CB	0.72	Recept DRESSING ROOM PLUG MOLD	20†
21†	Lighting THEATER STORAGE - SOUTH	0.43	20/1 CB	•	20/1 CB	0.54	Recept DRESSING ROOM PLUG MOLD	22†
23	Spare	0.00	0/1 CB	•	20/1 CB	1.08	Recept BOILER ACTING STUDIO / BACKSTAGE	24†
25	Spare	0.00	20/1 CB	•	20/1 CB	1.08	Recept BOILER ACTING STUDIO/ELEV LOBBY/TH S	26†
27	Spare	0.00	20/1 CB	•	20/1 CB	1.08	Recept BOILER ACTING STUDIO - CATWALK	28†
29	Spare	0.00	20/1 CB	•	20/1 CB	0.72	Recept STAGE	30†
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34
35	Spare	0.00	20/2 CB	•	20/1 CB	0.00	Spare	36
37	-------	0.00	------- ---	•	20/3 CB	0.00	Spare	38
39	Spare	0.00	30/2 CB	•	------- ---	0.00	-------	40
41	-------	0.00	------- ---	•	------- ---	0.00	-------	42

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Revised circuits marked ‡ Existing circuits marked †

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	ØA	ØB	ØC
Connected KVA	7.97	4.93	5.48

* Circuit Breaker Code
G = GFCI
S = Shunt Trip
D= Switching Duty
A = AFCI
H= HID Rated
C = HACR Rated
# = see note

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	2.33	x 100%	2.33	6	x 125%	8
Recept	15.36	10 KVA @ 100%, rest @ 50%	12.68	35	x 100%	35
Misc	0.68	x 100%	0.68	2	x 100%	2
	18.37	51 Amps	15.69	44		45

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.

1.2 SUMMARY

A. This section includes switches, receptacles, dimmers, device plates and multi-outlet assemblies.

B. Related sections include 260923 - Lighting Control Devices.

1.3 REFERENCES

A. National Electrical Manufacturers Association (NEMA).

B. Underwriters Laboratories (UL).

1.4 SUBMITTALS

A. Make submittals in accordance with Section 260500 - Common Work Results For Electrical. Submit product data for each device utilized in the project.

1.5 COORDINATION

A. Provide receptacles to match plug configurations for Owner-furnished equipment.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Subject to compliance with requirements, provide products by one of the manufacturers listed in the following paragraphs. All devices utilized on the project shall be from the same manufacturer.

2.2 RECEPTACLES

A. Specification Grade: Duplex NEMA 5-15R configuration (15 amp, 120V), Federal Specification WC-596F, back and side wired, nylon face, unless shown otherwise. Bryant BRY5262-I, Cooper 5262V, Hubbell HBL 5262I, Leviton 5362-I, or Pass and Seymour 5262-AI.

B. Ground Fault Circuit Interrupter (GFCI) Receptacle: Specification Grade, NEMA 5-15R configuration, duplex receptacle with 4-6 milliamps leakage current trip level. Feed through type to protect downstream receptacles on the same circuit. . Meets July 28, 2006 UL Standard 943. Cooper VGF15, Hubbell GF15IL, Leviton 7599-I, or Pass and Seymour 1595-SI.

C. Tamper-Resistant Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Cooper TR8300, Hubbell BR20ITR, Leviton TBR20, Pass and Seymour 63H.

D. Weather Resistant Receptacles, 125V, 15 A, listed as weather resistant type per NEC Article 406.8. Hubbell HBL5261IWR or equivalent by manufacturer listed in 2.2A.

2.3 SWITCHES

A. Specification Grade, Federal Specification WS-896, back and side wired, rated 277 volt, 20 amp. Single pole, double pole, keyed, 3- way, pilot light, locking type as required or as noted. Bryant 4901-I, Cooper 1221V, Hubbell 1221-I, Leviton 1221-I, or Pass and Seymour PS20AC1-I.

B. Interchangeable type rated same as above.

C. Pilot light switches: Lighted handle when "ON", or with separate pilot light.

2.4 WALL BOX DIMMERS

A. Incandescent Dimmers: Incandescent wall box dimmers rated for incandescent, inductive or low voltage loads, as required by the load served. Dimmer shall have slider control with full off at bottom of slide, power failure memory, and RFI filter. Dimmer shall have thin profile heat-sink, screw less face plate and gang with other switches and dimmers utilizing a continuous faceplate. Provide dimmer rated for 100% of the maximum wattage that can be installed in the controlled fixtures (minimum). Lightolier Vega Series, or Lutron Nova T* Series.

B. Fluorescent Dimmers: Fluorescent dimmers shall be compatible with the fluorescent dimming ballasts installed in the fixtures to be controlled. Dimmer shall have slider control with full off at the bottom of slide, power failure memory, and RFI filter. Dimmer shall have thin profile heat-sink, screw less face plate and gang with other switches and dimmers utilizing a continuous face plate. Lightolier Vega Series, or Lutron Nova T* Series.

2.5 COLOR

A. Ivory for switch handles and receptacle faces except as follows:
1. Red for emergency circuits.

2.6 DEVICE PLATES

A. Configuration: Single and combination type to match corresponding wiring devices.

B. Attachment Screws: Metal with head color to match plate finish.

C. Interior Surface Boxes: Pressed raised steel to match size of outlet box.

D. Exterior: Weather resistant hinged cover, Hubbell Bell 5028-0, Leviton 4992. For other receptacles provide cover to match receptacle.

E. Exterior: Rain tight while in use hinged cover, Hubbell Bell 5752-0, Cooper WIU-1, Leviton 5977-CL,. For other receptacles provide cover to match receptacle.

F. Identification: For receptacles other than 15 and 20 amp, 120 volts, provide tape label on faceplate with ampere rating, voltage and phase. Minimum lettering size 3/16".

G. Identification: For all receptacles, provide tape label on faceplate with panel and circuit number clearly visible. Minimum lettering size 3/16”.

2.7 MULTI-OUTLET ASSEMBLY

A. Provide assemblies complete, including necessary fittings and hardware with circuits as indicated on drawings. Outlet spacing as indicated except a receptacle shall be located within 0'-8" of each end and no receptacles shall be installed over sinks. All assemblies to contain ground wire.
1. Metal: 4 wire, 2 circuit, 12” outlet spacing, ivory color. Wiremold 20GBA_12 series or Hubbell HBL20GB_12 series.

PART 3 EXECUTION

3.1 MOUNTING

A. Rigidly fasten (without play) outlet boxes and devices at proper position with wall to bring receptacle flush with plate or switch handle the proper distance through plate. Align devices and plates plumb.

3.2 RECEPTACLES

A. Provide 15 amp receptacles in all locations except provide 20 amp receptacles on dedicated 20 amp circuits.

B. Provide weather resistant receptacles for all exterior receptacles.

C. Provide surge protection receptacle in the locations shown on the drawings.

D. Provide isolated ground receptacles in the locations shown on the drawings.

E. Provide exterior, GFCI receptacle within 25'-0" of each roof mounted mechanical equipment, for all outdoor receptacles, and other locations shown on the drawings.

3.3 ORIENTATION

A. Set switches with handle operating vertically, up position "ON". Set receptacles vertically with ground pin up or when construction requires horizontal mounting ground pin left.

3.4 DEVICE PLATES

A. Provide for wiring devices, telephone and signal outlets. Plate to cover cutout for device outlet box.

B. For remodel projects or for additions to existing construction provide new plates on existing outlet boxes unless the existing plate matches new plates in construction and appearance.

C. Install device plates after painting is complete.

D. Provide exterior rain tight while in use covers for exterior receptacles in wet locations. Otherwise provide weather resistant covers.

3.5 MULTIOUTLET ASSEMBLIES

A. Rigidly fasten assemblies to the cabinet, wall, casework, or modular casework as indicated. Provide a chase nipple extension between outlet box in the wall and the raceway when the raceways are mounted to the support channels for the modular casework.

3.6 DIMMERS

A. Install wall box dimmers to achieve circuit rating after derating for ganging as required by manufacturer.

B. Do not share neutral conductor on load side of dimmers.

3.7 CLEANING

A. Remove excess plaster from interior of outlet boxes.

B. Clean devices and coverplates after painting is complete. Replace stained or improperly painted devices or coverplates.

END OF SECTION

INTERIOR 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.

1.2 SUMMARY

A. Provide lighting system complete and fully operational.

B. Substitutions:
   1. Bidders requesting approval to provide products other than those specifically listed in the Light Fixture Schedule shall submit requests in writing to the Architect and Lighting Designer ten days prior to the close of the bid period. Approval will be in the form of an addendum to the specifications issued to all registered plan holders. No requests for substitution will be considered after this date.
   2. Substitution request shall include all information required under paragraph 1.4 SUBMITTALS. Requests for approval shall be accompanied by a working fixture sample (including lamps and a cord and plug). Provide the name of at least one installation where each proposed substitute has been installed for at least six months along with the name and phone number of the Architect, Owners representative and the Lighting Designer of Record. If required by the Architect, the proposed substitutes must be installed at the bidders expense in a location selected by the Architect.

1.3 REFERENCES

A. National Electrical Manufacturer's Association (NEMA) LE5-1993:
   1. Procedure for determining Luminaire efficiency ratings.

B. Underwriters Laboratories, Inc. (UL):

UL 496:	Edison Base Lampholders
UL 542:	Lampholders, Starter Holders for Fluorescent Lamps
UL 676:	Underwater Lighting Fixtures
UL 924:	Emergency Lighting and Power Equipment
UL 935:	Fluorescent Lamp Ballasts
UL 1012	Power Units Other Than Class 2
UL 1029:	HID Lamp Ballasts
UL 1310	Class 2 Power Units
UL 1570:	Fluorescent Lighting Fixtures
UL 1571:	Incandescent Lighting Fixtures
UL 1572:	High Intensity Discharge Lighting Fixtures
UL 1574:	Track Lighting Systems
UL 1598	Luminaires

1.4 SYSTEM DESCRIPTION

A. Light fixture schedule series numbers are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of lamp, ballast, finish trim, ceiling type, mounting hardware, ceiling trim or special requirements as specified hereinafter or as required by the particular installations. Provide complete fixtures to correspond with the number of lamps, wattage and/or size specified.

B. If there are discrepancies between fixture illustrations and the written description in the fixture schedule, the written description in the fixture schedule shall take precedence.

C. Light fixture voltage shall match voltage of circuit serving the light fixture.

1.5 SUBMITTALS

A. For standard catalog items, provide original product sheets, -neatly and clearly marked- to indicate that light fixture, ballasts and lamps fully comply with contract documents. Include photometric report by an independent certified testing laboratory when required in fixture schedule. Manufacturer's test report is not acceptable.

B. Submittals shall have fixture types and project name clearly indicated and shall be prepared by the authorized manufacturer's representative serving the project area. A list of manufacturer's representatives (including address, telephone and fax numbers) identifying which light fixture types they represent shall be included with submittals. Submittals or requests for substitutions not meeting these requirements will be rejected.

C. For custom fixtures, modified fixtures or linear fluorescent fixtures mounted in continuous rows, submit scaled drawings prepared by the manufacturer showing details of construction, lengths of runs, pendant and power feed locations, accessory pieces, finishes, and list of materials. Contractor to provide manufacturer with field dimensions where required.

D. Product Samples, complete with housing, trim with 8’ cord, plug, and specified lamp shall be submitted if requested in the fixture schedule.

1.6 QUALITY ASSURANCE

A. Fixtures and components shall be new and listed by Underwriters Laboratories (UL) or other testing lab acceptable to local jurisdiction.

1.7 WARRANTY

A. Ballasts: Provide manufacturer’s warranty for a period of not less than five years. Warranty shall include parts and labor to replace defective ballasts.

B. Exit Signs Utilizing LED Lamp Technology: Provide manufacturer’s warranty for a period of not less than five years including parts and labor for full replacement of defective product.

C. LED Luminaires: Provide manufacturer's warranty for a period of not less than three years for repair or replacement of defective electrical parts, including light source and power supplies.

1.8 EXTRA MATERIALS

A. Ballasts: Provide one case or 10% (whichever is less) of each type used on the project. Turn over to Owner and obtain signed receipt.

B. Lamps: Provide one case or 10% (whichever is less) of each type used on the project. Turn over to Owner and obtain signed receipt.

C. Fuses: Provide one case or 10% (whichever is less) of each type used on the project. Turn over to Owner and obtain signed receipt.

D. Adjustable Accent Lights (track, recessed or surface mounted): Provide additional lenses, color filters and other accessories to be used during final focusing, as follows:
   1. 20% or one case (whichever is less) of each lamp type (type, beam spreads, and wattages to be determined by the lighting designer). A spot and a flood lamp of the same wattage are considered to be two different lamp types.
   2. 10% or one dozen each, (whichever is less) lenses, color filters and louvers (to be determined by the lighting designer).

PART 2 PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

A. Finish ferrous mounting hardware and accessories to prevent corrosion and discoloration to adjacent materials.

B. For vaportight installations, painted finishes of fixtures and accessories shall be weather resistant enamel using proper primers or galvanized and bonderized epoxy, so that the entire assembly is completely corrosion resistant for the service intended. Where aluminum parts come into contact with bronze or steel parts, apply a coating material to both surfaces to prevent corrosion.

C. Fixtures shall be free of light leaks and designed to provide sufficient ventilation of lamps to provide the photometric performance required. Ballasts and transformers shall be adequately vented.

D. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. Intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. Finish exposed

edges so no sharp or ragged edges are exposed. All miters shall be in accurate alignment with abutting intersecting members.

E. Lampholders shall hold lamps securely against normal vibrations and maintenance handling.

F. Reflector Cones:
1. Provide minimum 45° lamp and lamp image cut-off for all vertically mounted lamps. For horizontal lamps provide minimum 33° cut-off. There shall be no visible lamp flashing in the cone.
2. Plastic materials shall not be used for reflector cones, unless noted otherwise in the Light Fixture Schedule.
3. Reflector cones shall not be riveted or welded to housing and shall be removable without tools. Retention devices shall not deform the cone in any manner. Trim shall be flush with finished ceiling without gaps or light leaks. Where the flange trim is separate from the cone, it shall have the same finish as the cone.
4. Reflector cones shall be of uniform gauge, not less than 0.032-inch thick, high purity aluminum Alcoa 3002 alloy, free of spin marks or other defects.
5. Manufacture reflector under the Alzak process. Refer to fixture schedule for cone color and specular or diffuse finish requirements. For fixtures using compact fluorescent lamps, provide additional finish equivalent to Color-Chek that eliminates iridescence. Submit one sample of each cone type for review when required in the fixture schedule.

G. Fresnel Lens and Door Assembly:
1. Lens shall have uniform brightness throughout the entire visible area at angles from 45° to 90° from vertical, without bright spots or striations.
2. Lens shall have opaque risers painted neutral gray unless otherwise specified in the Light Fixture Schedule.
3. Finish of regress door shall be matte baked enamel paint in color as selected by the Architect.

H. Light fixtures containing lamps which require protective shielding shall have tempered glass lenses.

I. For adjustable fixtures, provide positive locking devices to fix aiming angle. Fixture shall be capable of being relamped without adjusting aiming angle.

J. Fixtures recessed in suspended ceilings where the space above the ceiling is either an air supply or return plenum shall conform with NEC Article 300-22.

K. Safety: Provide safety devices for removable fixture elements (cones, reflectors, lenses, etc.) to support removable elements when not in normal operating position. Safety devices shall be detachable if necessary and shall not interfere with fixture performance, maintenance or the seating of any fixture element, and not be visible during normal fixture operation.

2.2 FLUORESCENT FIXTURES

A. Housing: Minimum code gauge steel or rigid aluminum construction painted after fabrication with high reflectance white paint (min. 89%).

B. Light Shields:
1. Parabolic Louvers: Provide Alzak aluminum, specular or semi-specular as specified, with a low-iridescent finish.
2. Flat Translucent Diffusers: Shall be 100% virgin DR acrylic and have matte finish on exterior side (facing away from lamps). Diffuser shall be of thickness specified and shall be of sufficient density to completely obscure lamp image.
3. Flat Clear Lenses: Injection molded 100% virgin DR acrylic or clear tempered glass, thickness as specified.
4. Clear Patterned Lenses: Injection molded 100% virgin DR acrylic. For lenses with a male pattern of prisms or cones, specified minimum thickness refers to distance from flat surface to base of pyramids or cones, or to thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material. Lenses shall fully eliminate lamp image when viewed from all directions between 45-90° from vertical. From 0-45° the ratio of maximum brightness (under a lamp) to minimum brightness (mid-point between lamps) shall not exceed 3:1. Minimum thickness shall not be less than 0.125" with a minimum weight of 8 ounces per square foot.

C. Frames:

1. Supply with concealed hinges and latching. Provide mitered corners with no gaps or light leaks.

D. Lamp Mounting:
1. Mount lamps used in rapid start circuits 430 ma and below within 1/2" of grounded metal as long as the lamp. For 800 ma and 1500 ma lamps, mount within 1" of grounded metal as long as the lamp.
2. For rapid start circuits using single lamp ballasts, provide one grounding lamp holder per lamp.

2.3 INCANDESCENT/TUNGSTEN HALOGEN FIXTURES

A. Tungsten halogen and xenon are types of incandescent light sources and will herein be included under the heading of incandescent.
1. Finish: Concealed parts (lamp holders, yokes, brackets, etc.) matte black.
2. Tungsten Halogen Lamp Seal Temperature: Shall not exceed 350°C at ambient of 25°C when tested per UL Bulletin 57, Paragraph 328-334. Submit certified heat test by independent testing laboratory when required in Light Fixture Schedule.

2.4 HIGH INTENSITY DISCHARGE (HID) FIXTURES:

A. Housing: Minimum code gauge steel, bonderized or equal rust protected or rigid aluminum construction.

B. Finish: Visible surfaces. Powder coated paint unless otherwise specified. Color and finish as selected by architect. Concealed parts, (lamp holders, yokes, brackets, etc.) matte black.

C. Lamp Holder Housing: Cast aluminum with integral heat radiating fins to assure cool lamp base operation.

2.5 LIGHT EMITTING DIODE (LED) FIXTURES:

A. Housing: Rigid aluminum construction.

B. Finish: Visible surfaces. Powder coated paint or natural aluminum as specified in Light Fixture Schedule. Color and finish as selected by architect. Concealed parts, (lamp holders, yokes, brackets, etc.) matte black.

C. Lamp Holder Housing: Cast aluminum with integral heat radiating fins to assure cool lamp base operation, with sufficient heat dissipation to meet device manufacturer's guidelines, certification programs, and test procedures for thermal management.

D. Off-state Power: Luminaires shall not draw power in the off state. Exception: Luminaires with integral occupancy, motion, photo-controls or individually addressable fixtures with external control and intelligence are exempt from this requirement. The power draw for such luminaires shall not exceed 0.5 watts when in the off state.

2.6 WIRING

A. Wiring shall be as required by code for fixture wiring.

B. Flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105°C.

C. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.

D. No internal wiring shall be visible at normal viewing angles, i.e. above 45° from vertical.

E. Master Slave Fixtures: Supply ballasts in adjacent fixtures to operate one or more lamps in the adjacent fixture where required in Drawings or Light Fixture Schedule. For single lamp fixtures, provide a two-lamp ballast for two adjacent fixtures. For three-lamp fixtures, provide one two-lamp ballast for the outboard lamps in each fixture and an additional two-lamp ballast for the center lamp in each of two adjacent fixtures.

F. Tandem Wired Fixtures: For fixtures in continuous rows and where required in Drawings or Light Fixture Schedule, supply ballasts and wiring to control all top or inboard lamps together and control all bottom or outboard lamps together.

G. Provide #18 AWG, 3-wire flexible conduit connections (whips) for dual level switching as shown on Drawings for light fixtures recessed in accessible suspended ceilings. Provide 3-wire whips for all dual level switching. Wire count on wire whips is not shown on Drawings and shall be the responsibility of the Contractor to provide proper wire count for the lighting control as shown on Drawings.

2.7 BALLASTS AND POWER SUPPLIES:

A. Fluorescent General Requirements:
1. Lamps shall be operated on the type of circuit the lamp was designed for (preheat, rapid start, instant start, programmed start, etc.). T8 lamps shall be operated on rapid start or programmed rapid start ballasts only. Ballasts shall provide normal rated lamp life as stated by lamp manufacturers.
2. Ballasts shall be HPF (greater than 90%), UL listed, and ETL certified. Magnetic ballasts shall be CBM certified. For projects applying for utility funding, ballasts shall meet utility requirements. Provide ballasts with thermal protection unless otherwise specified. Ballasts shall be Class P.
3. Confirm voltage requirements with Electrical Drawings. Ballasts shall operate lamps correctly within +/-10% voltage variation without damaging ballasts.
4. Ratings:
   a. "A" sound rating for 430 ma and 265 ma
   b. "B" sound rating for 800 ma
   c. "C" sound rating for 1500 ma
5. Provide a ballast disconnecting means for all fixtures that utilize double ended fluorescent lamps in accordance with NEC 410.130(G).
6. Low temperature application: Provide ballasts suitable for low starting temperature where light fixture is located in a freezer or refrigerator or other location where ambient air temperature will be below 50 degrees F.
7. Dimming Ballasts: Type required by dimmer manufacturer for proper operation and to maintain UL listing of dimming system components utilized. Total harmonic distortion shall not exceed 20% at any point within the dimming range. For T5HO lamps, ballasts must meet proposed IEC dimming parameters and all other industry requirements to maintain lamp manufacturer's warranties. Ballasts known to meet these parameters are Advance VZT2S54 and REZ2S54 and Lutron FDB-T554 and ECOT554 for one or two lamps for 120 or 277v operation.

B. Magnetic Fluorescent Ballasts: In addition to the general requirements, provide magnetic ballasts where required in the Light Fixture Schedule as follows:
1. Energy saving type with a ballast factor not less than 95%.
2. Each ballast individually protected by an in-line GMF fuse in a Bussman type HLR fuseholder.
3. Manufacturers: Advance, GE/Magnatek, Robertson or Universal, or as specifically noted in the Light Fixture Schedule.

C. Electronic Fluorescent Ballasts: In addition to the general requirements, provide electronic ballasts where required in the Light Fixture Schedule as follows:
1. Ballasts in conformance with the following regulatory requirements:
   a. EMI and RFI limits set by the FCC (CFR47, Part 18 and FCC Part 18,15j), IEEE Publication 587, Category A (transients).
   b. Minimum efficiency standards of Public Law 100-357.
   c. Starting sequence consistent with ANSI Standard C82.1-1993.
2. Reduced light output ballasts (ballast factors below 87%) are not acceptable except as noted otherwise in the Light Fixture Schedule.
3. Total harmonic distortion shall be less than 15% of the input current. Current crest factor shall be less than 1.7. Operating frequency shall be between 25 and 60 kHz with no visible flicker.
4. Ballasts shall operate in ambient temperatures up to 105°F (40°C).
5. Rapid start ballasts shall be wired in series (or in parallel if manufactured accordingly).
6. Ballasts for single ended lamps shall be program start, with end of life protection.
7. Manufacturers: Advance, GE/Magnatek, Osram/Sylvania, Universal.

D. High Intensity Discharge:
1. HPF type (minimum power factor 90%).
2. Sound Rating: "low noise" or "extra quiet".
3. Each ballast shall be individually protected by an in-line fuse in a Bussman fuseholder type HLR for 120 and 277 volt, type HEX for 208, 240 and 480 volt.
4. Metal Halide: Up to 500 watts shall be pulse start. Probe start ballasts are only acceptable above 500 watts.
5. Manufacturers - Magnetic Ballasts: Sylvania, Holophane, Jefferson, Advance, Universal.

6. Where ceramic metal halide lamps are specified, use electronic ballasts with low frequency square wave output platform, less than 200Hz to prevent acoustic resonance inside the lamp arc tube and minimize visible flicker. Lamp current crest factor of less than 1.5.
7. Manufacturers - Electronic Ballasts: Vassloh-Schwabe (exAromat) (for 39, 50, 70, 100 and 150 watts); Advance (for 39, 50, 70, 100 and 150 watts); Altman (150 watts), Innova (150 watt S/E T-6), Reliable (39WPAR20, 50, 70 and 100 watts), OSRAM (exMotorola) (70 watts) and Hatch (39 and 70 watts).

E. LED Power Supplies:
1. Minimum power factor 90%.
2. Minimum operating temperature of -20°C.
3. Output operating frequency shall be minimum 120 Hz.
4. Power supply shall meet FCC requirements for non-consumer use.
5. Sound rating: Class A.
6. Power supply shall comply with IEEE C.62.41-1991, Class A operation.

2.8 LAMPS

A. Each lamp type in the Project shall be manufactured by the same manufacturer.

B. Fluorescent:
1. Medium Bi-pin, T5 program start, T8 rapid start, T12, compact TT , DTT and TRT; 3500K color temperature and 80+ Color Rendering Index (CRI) unless otherwise noted. Use TCLP compliant lamps unless they are unavailable for type of lamp specified (brand names are GE - Ecolux, Osram Sylvania - Ecologic and Phillips - ALTO).
2. Manufacturers: General Electric, Philips, Osram Sylvania or as specifically noted in the Light Fixture Schedule.

C. Incandescent (Including Tungsten Halogen):
1. General Service Lamps: Inside frosted, 120V, filament lamps with a minimum 1000 hours rated life.
2. Lamps with diodes are not acceptable.
3. At time of installation, provide HIR technology lamps for standard voltage PAR lamps and double ended tungsten halogen lamps, unless HIR technology is not available for specified lamps.
4. For low voltage lamps with dichroic reflectors, use Constant Color type (by General Electric) or aluminum back finishes. Coating on back of lamp shall be sufficiently dense and even to prevent light and heat from escaping out the back side of the reflector.
5. Manufacturers: General Electric, Philips, Osram Sylvania or as specifically noted in the Light Fixture Schedule.

D. High Intensity Discharge Type:
1. For indoor applications provide color corrected HPS (minimum 65 CRI) or color corrected metal halide (minimum CRI 65). For exterior applications provide clear metal halide or high pressure sodium unless specified otherwise.
2. Refer to fixture schedule for specific metal halide and high pressure sodium lamps required. Mercury Vapor shall not be used.
3. Acceptable manufacturers: General Electric, Osram Sylvania, Philips, Venture or as specifically noted in the Light Fixture Schedule.

E. Light Emitting Diode Type:
1. LED modules/arrays shall have a minimum CRI of 80 unless otherwise specified in the Light Fixture Schedule.
2. Color temperature variation shall not exceed +/- 100 degrees Kelvin at installation, and +/- 200 degrees Kelvin over the life of the module.
3. LED modules/arrays shall deliver at least 70% of initial lumens, when installed in-situ, for a minimum of 35,000 hours.
4. Acceptable manufacturers: Cree, Philips, Nichia.

2.9 SOCKETS

A. Incandescent: Porcelain for medium or mogul screw base. For other lamp types, as required by base type.

B. Fluorescent: Suitable for lamp and ballast type employed.

2.10 H.I.D.

A. Porcelain for mogul or medium base lamps, pulse rated as required. Keyed for all position oriented lamps. For other lamp types, as required by base type.

2.11 EMERGENCY BATTERY PACKS

A. Where fluorescent fixtures are indicated or specified to have self-contained battery backup, provide battery pack(s) with 1100 lumen output for single lamp operation or as indicated. Unit shall have high temperature nickel cadmium battery, automatic transfer switch, battery charger high frequency inverter, installed test/charging indicator and switch, dual voltage, and be UL listed to standard 924. Provide normal switching connection where indicated.

B. Testing: Apply power for 24 hours, disconnect power observe, measure and record light output for specified 90 minute period. Continue to run on battery until automatic low battery cut-off circuit disconnects battery. Restore normal power and verify battery returns to charging mode.

C. Warranty: Entire unit shall be warranted for 5 years, battery shall have 15 year life expectancy with 5 year full warranty and 7 additional years prorated warranty. Full warranty to cover labor and materials without charge. Prorated warranty to cover material only.

PART 3 EXECUTION

3.1 LIGHTING FIXTURES, GENERAL

A. Provide mounting accessories and trims as required for wall and ceiling construction types shown in Finish Schedule and on Drawings.

B. Verify weight and mounting method of fixtures and provide suitable supports. Fixture mounting assemblies shall comply with local seismic codes and regulations.

C. Refer to architectural reflected ceiling plans for coordination of lighting fixture locations with mechanical and fire safety equipment. Where conflicts occur, coordinate with Architect prior to installing any of the systems.

D. Install fixtures with vent holes free of air blocking obstacles.

E. Lighting fixtures located in recessed ceilings with a fire resistive rating of 1-hour or more shall be enclosed in an approved fire-resistive rated box equal to that of the ceiling.

F. Adjust aperture rings on all recessed fixtures to be flush with the finished ceiling.

G. For fluorescent lamps operated on dimming ballasts, operate lamps at full output for 100 hours (continuous burn) before dimming.

H. Adjust variable position lampholders for proper lamp position prior to fixture installation.

I. Blemished, damaged or unsatisfactory fixtures or accessories shall be replaced.

J. For pendant mounted fixtures, mounting height is from finished ceiling to top of pendant light fixture. For wall mounted fixtures, center on outlet box unless otherwise noted. Verify mounting provisions and other requirements prior to order of light fixtures and provide as required.
   1. Exit Signs:
      a. Wall Mounted: Locate bottom of exit sign 4 in. above top of door frames. Typical unless otherwise noted on the drawings.
      b. Ceiling Mounted: Mount directly to ceiling for all ceiling heights 9 ft.-6 in. and lower. For ceiling heights above 9 ft.-6in., provide stem such that the bottom of the exit sign is located 4 in. above the top of the door frame. Typical unless otherwise noted.

K. In accessible suspended ceilings, provide 72" flexible conduit wiring connection (flexible tubing not permitted) from a rigidly supported junction box.

L. All finishes shall be unmarred upon project completion. Repair or replace damaged finishes.

M. Replace all burned out or inoperative lamps at the end of the construction prior to Owner occupancy.

N. All lighting fixtures shall be installed square to main building elements. Coordinate with Owner and Architect.

3.2 DIFFUSERS AND ENCLOSURES

A. Remove protective plastic covers from lighting fixture diffusers only after construction work, painting and clean-up are completed. Remove all dirty lamps, reflectors and diffusers; clean and reinstall. When cleaning "Alzak" reflectors, use a manufacturer recommended cleaning solution. Reflectors damaged or impregnated with fingerprints shall be replaced at no cost to Owner.

3.3 ADJUSTMENT OF LIGHT FIXTURES

A. Focus all adjustable light fixtures under the direction of the Lighting Designer during a scheduled period of time prior to the completion of the project, after normal business hours if required. Include all equipment and personnel expenses (including overtime) required for adjustment.

3.4 SUPPORT OF INCANDESCENT AND COMPACT FLUORESCENT LIGHT FIXTURES

A. Surface or Pendant Type: Attach heavy formed steel straps to the outlet box by means of threaded stems with locknuts, or directly to the outlet box where the light fixture is specifically so designed.

B. Recessed Type: Mount in frames suitable for the ceiling, with recessed portion of the fixture securely supported from the ceiling framing. Bottom of light fixture to be flush with adjacent ceiling. Fixture trim shall totally conceal ceiling opening. Provide two #14 earthquake chains or #12 wires when fixture is supported by ceiling suspension system.

3.5 SUPPORT OF FLUORESCENT LIGHT FIXTURES

A. Recessed type: For light fixtures supported by the ceiling suspension system, provide four Caddy #515 support clips (one each corner) which lock light fixture to ceiling tees after light fixture is installed. In addition, provide for each light fixture two #14 earthquake chains or #12 wires secured at diagonally opposite fixture corners (for fixtures weighing less than 56 pounds) to structural members above suspended ceiling. For plaster or gypsum board ceilings provide plaster frame compatible with light fixture. Contractor shall coordinate fixture trim with ceiling type.

B. Surface Mounted Type:
   1. Where mounted on accessible ceilings, support from structural members above ceiling by means of hanger rods through ceiling or as approved.
   2. Continuous Runs of Fixtures: Laser sight to assure fixtures are straight when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.

C. Pendant Mounted Type:
   1. For fixtures with rigid pendants, supply swivel ball aligners at canopy to comply with local seismic requirements.
   2. Where suspended from accessible ceiling, support fixture from structural members above ceiling by means of hanger rods through ceiling or as accepted.
   3. Continuous Runs of Light Fixtures: Laser sight to assure fixtures are straight when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.

3.6 SUPPORT OF HIGH INTENSITY DISCHARGE FIXTURES

A. As specified for incandescent light fixtures, except provide access as required for ballast. Provide earthquake chains when light fixture is supported by the ceiling suspension system. For remote ballasts, isolate ballast from structure.

3.7 CEILING LIGHT FIXTURE SUPPORT

A. Where ceiling is of insufficient strength to support weight of lighting fixtures installed, provide additional framing to support as required.

END OF SECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes general electrical requirements for all Division 27 work and is supplemental and in addition to the requirements of Division 1.

B. It is the intention of this Division of the Specifications and the Contract Drawings to describe and provide for the furnishing, installing, testing and placing in satisfactory and fully operational condition all equipment, materials, devices and necessary appurtenances to provide a complete electrical system. Provide all materials, appliances and apparatus not specifically mentioned herein or shown on the drawings, but which are necessary to make a complete, fully operational installation of all electrical systems shown on the contract drawings or described herein. Connect equipment and devices furnished and installed under other Divisions of this specification (or the Owner) under this Division.

C. Workmanship shall be of the best quality and competent and experienced electricians shall be employed and shall be under the supervision of a competent and experienced foreman.

D. The drawings and specifications are complimentary and what is called for (or shown) in either is required to be provided as if called for in both.

E. See Division 1 for sequence of work.

1.3 CODES, PERMITS, INSPECTION FEES

A. The following codes and standards are referenced in the Division 27 specifications. Perform all work and provide materials and equipment in accordance with the latest referenced codes and standards of the following organizations:
1. American National Standards Institute (ANSI)
2. National Electrical Manufacturer's Association (NEMA)
3. National Fire Protection Association (NFPA)
4. Underwriter's Laboratories (UL)

B. Install the electrical systems based on the following:

NFPA 70	National Electrical Code as adopted and amended by the Local Jurisdiction.
IBC	International Building Code as adopted and amended by the Local Jurisdiction.

C. The referenced codes establish a minimum level of requirements. Where provision of the various codes conflict with each other, the more stringent provision shall govern. If any conflict occurs between referenced codes and this specification, the codes are to govern. Compliance with code requirements shall not be construed as relieving the Contractor from complying with any requirements of the drawings or specifications which may be in excess of requirements of the governing codes and rules and not contrary to same.

D. Obtain and pay for all licenses, permits and inspections required by laws, ordinances and rules governing work specified herein. Arrange for inspection of work by the inspectors and give the inspectors all necessary assistance in their work of inspection.

1.4 WARRANTY

A. Refer to General Conditions of the Contract.

1.5 CORRECTION OF WORK

A. Within one year after the date of Substantial Completion of the work, the Contractor shall correct any work found to be not in conformance with the Contract Documents promptly after written notice from the owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive acceptance of the work under this Contract and termination of the Contract. The Owner shall give such notice promptly after discovery of the condition.

1.6 PRICING

A. Basic Bid: Include all labor and materials required for the furnishing, installing, testing, and placing in satisfactory and fully operational condition all equipment, materials, devices, and necessary appurtenances to provide a complete telecommunications cabling system for the project as indicated and specified.

B. Alternate Bids: Each Bidder shall include with his proposal, in the spaces provided therefore in the "Form of Bid," alternate proposals for adding, or substituting, materials and construction to, or for deleting materials and construction from, the Basic Bid. The alternate proposal figure shall indicate the difference in price, or the amount to be added to or deducted from the Basic Bid for the construction or installation of work included in the alternate bid.

C. Unit Pricing: Provide unit prices including shop drawings, engineering, and any system programming required for each device to add/delete the following:
   1. Voice/Data Outlet, per outlet to a maximum of 100 outlets, including:
      a. (3) Permanent Links, including Cat 6 cables from Telecom Room to outlet, installed. Nominal length of 280 ft each cable.
      b. All connectors and terminations at the outlet and in the Telecom Room.
      c. Faceplate and (pro-rated portion of) 110 block.
      d. (2) Patch cables - 110 block to data equipment within Telecom Room.

1.7 ITEMIZED SCHEDULE OF COSTS

A. Complete the Schedule of Values included at the end of this section. This schedule shall be adhered to for the electrical contractor to facilitate analysis and approval of the monthly progress billings. Refer to the Supplementary Conditions of General Contract and Division 1 - General Requirements for details, and conform thereto. Provide a copy directly to Sparling.

1.8 SUBMITTALS AND SHOP DRAWINGS

A. Submittals and Shop Drawings: Schedule so as not to delay construction schedule and no later than 60 days after award of contract, submit common brochure(s) with index and divider tabs by specification section, containing all required catalog cuts. Allow two weeks for review for each submittal and resubmittal. Incomplete submittals and shop drawings which do not comply with these requirements will be returned for correction, revision and resubmittal. See General Conditions for format, quantity, etc.

B. Submit in a three ring binder with hardboard covers. Submittals shall show:
   1. Indicate listing by UL or other approved testing agency.
   2. Highlight with yellow or blue marker adequate information to demonstrate materials being submitted fully comply with contract documents.
   3. Review and check all material prior to submittal and stamp "Reviewed and Approved".

C. Shop drawings shall show:
   1. Ratings of items and systems.
   2. How the components of an item or system are assembled, interconnected, function together and how they will be installed on the project.
   3. System layout floor plans with complete device layout, point-to-point wiring connection between all components of the system, wire sizes and color coding.
   4. Coordinate with other division shop drawings and submittals. Identify interface points and indicate method of connection.

D. The Contractor agrees:
   1. Submittals and shop drawings processed by the Architect are not change orders.
   2. The purpose of submittals and shop drawings by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept.
   3. Submittals demonstrate equipment and material Contractor intends to furnish and install and indicate detailing fabrication and installation methods Contractor intends to use.
   4. To accept all responsibility for assuring that all materials furnished under this Division of the specifications meet, in full, all requirements of the contract documents.
   5. To pay for Engineers review cost of submittal review beyond one resubmittal.

E. The Engineer's review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Corrections or comments

made during this review do not relieve contractor from compliance with the requirements of the drawings and specifications. Contractor is responsible for: Dimensions which shall be confirmed and correlated at the job site; fabrication process and techniques of construction; coordination of his work with that of all other trades; performing his work in a safe and satisfactory manner.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Provide (6) copies of O&M manuals required in plus one manual for Sparling for all equipment furnished under this Specification. Submit a preliminary copy, complete except for the bound cover, 60 days prior to completion of the project for checking and review. Deliver final bound corrected copies plus a copy to Sparling 20 days prior to scheduled instruction periods.

B. The information included must be the exact equipment installed. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.

C. These O&M manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the project. Present and arrange information in a logical manner for efficient use by the Owner's operating personnel. The information provided shall include but not be limited to the following:
   1. Equipment manufacturer, make, model number, size, nameplate data, etc.
   2. Dimensional and performance data for specific unit provided as appropriate.
   3. Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriate). Parts lists shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.
   4. Shop drawings.
   5. Wiring diagrams.
   6. A complete list of local (nearest) manufacturer representative and distributor contacts for each type of equipment and manufacturer. Include name, company, address, phone, fax, e-mail address, and web site.
   7. Provide revised Cable Termination Schedules of all cables installed under the Work. Schedules shall be in printed form and on CD disk and in the version of Microsoft Excel extant at the time of first submission.
   8. Cable Test Reports in CD form, including review software.
   9. Group the information contained in the manuals in an orderly arrangement by Specification paragraph. Provide a typewritten index and divider sheets between categories with identifying tabs. Bind the completed manuals with hard board covers not exceeding 5" thick. (Provide two or more volumes if required.) Imprint the covers with the name of the job, Owner, Architect, Technology Consultant, Contractor and year of completion. Imprint the back edge with the name of the job, Owner and year of completion. Hard board covers and literature contained may be held together with screw post binding.

1.10 RECORD DRAWINGS:

A. Continually record the actual cabling system installation on a set of prints kept readily available at the project during construction. These prints shall be used for this purpose alone.

B. Mark record prints with red erasable pencil. Mark the set to show the actual installation where the installation varies substantially from the work as originally shown.

C. Include addenda items and revisions made during construction.

D. Erase conditions not constructed or "X-out" and annotate "not constructed" to clearly convey the actual "as constructed" condition.

E. Organize record drawings sheets in manageable sets, bind and print suitable titles, dates and other identification on the cover of each set.

F. Transmit the record drawing set to the Owner at the completion of the work. Final payment to the contractor will not be authorized until these prints have been submitted to and accepted by the Owner.

G. Transfer the changes marked up on the record prints into AutoCAD Release 14 (or higher) at the completion of the work. Provide two (2) sets of prints, one set of fixed line reproducible drawings and one set of AutoCAD drawing files on Compact Disk. Transmit drawings, CAD files and the record

drawing mark-ups to the Owner. Final payment to the contractor will not be authorized until these document have been submitted to and accepted by the Owner

1.11 FINAL ACCEPTANCE REQUIREMENTS

A. Provide to the Owner, Record Drawings annotated with the changes made during the installation of the Work so as to be a complete set of "As Installed" plans. Drawings shall be in printed form and on CD disk in AutoCAD 2004 format.

B. Certificate of Compliance:
   1. Provide for Owner's documentation, a completion statement in form stipulated by the Owner and signed by the Contractor, stating that the Work was completed in compliance with the Contract Documents and that the installation was proper for the conditions of application and use.

1.12 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer shall have on staff personnel certified by BICSI.
   1. Layout Responsibility: Preparation of Shop Drawings and field testing program development shall be performed by a Registered Communications Distribution Designer (RCDD).
   2. Installation Supervision: Installation shall be under the direct supervision of a Level 2 Installer and shall be present at all times when Work of this section is performed at the Project site.

B. Source Limitations:
   1. Obtain all products except cables through one source from a single manufacturer.
   2. All Permanent Link components (including cables) of the workstation cable system shall be the products of one manufacturer.

C. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the authority having jurisdiction, and marked for intended use.

1.13 COORDINATION OF THE WORK

A. Carefully check space requirements and the physical confines of the area of work to insure that all material can be installed in the spaces allotted thereto, including conduits and cable supports.

B. Transmit to other trades in a timely manner all information required for work to be provided under their respective Sections in ample time for installation.

C. Wherever work interconnects with or contacts the work of other trades, coordinate with other trades to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment.

D. Due to the type of installation, a fixed sequence of operation is required to properly install the complete systems. Coordinate project and schedule work with the General Contractor in accordance with the construction sequence. Provide progress status of the installation to the General Contractor to allow them to update their project schedules.

E. Contractor shall note that the construction schedule may dictate that work must be carried out simultaneously in more than one building and on more than one floor.

F. Coordinate layout and installation of voice and data communications cabling with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangements with local exchange carrier.
   1. Meet jointly with the telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute to other participants.
   3. Adjust arrangements and location of distribution frames and cross-connect and patch panels in equipment rooms and wiring closets to accommodate and optimize arrangements and space requirements of the telephone switch and LAN equipment.

G. Attend all construction meetings, at the project site or other location, as requested by the Owner, Engineer, and/or General Contractor.

H. The Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper compliance with the design intent.

1.14 DELIVERY, STORAGE AND HANDLING

A. Deliver materials (except bulk materials) in manufacturer's unopened containers, fully identified with the manufacturer's name, trade name, type, class, grade, size and color.

B. Store materials suitably sheltered from the elements, but readily accessible for inspection until installed. Store all items subject to moisture damage in dry spaces. Provide space requirements for storage with the submittals. The General Contractor shall assign storage space.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials to be new, free from defects and not less than quality herein specified. Materials shall be designated to insure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.

B. Each type of materials furnished shall be of the same make, be standard products of manufacturers regularly engaged in production of such materials and be the manufacturer's latest standard design.

C. All materials, equipment and systems furnished that include provisions for storing, displaying, reporting, interfacing, inputting, or functioning using date specific information shall perform properly in all respects regardless of the century. Any interface to other new or existing materials, equipment or systems shall function properly and shall be century compliant, both in regards to information sent and received.

2.2 SUBSTITUTION OF MATERIALS

A. No Substitute: Where a specified product is indicated "no substitute", it is the intent of this specification to require new materials to be compatible with the existing installation or as specifically requested by the owner. To this end certain materials and systems no substitution will be allowed.

B. Prior to Bid Opening: Acceptance of products other than those specified will be issued by addendum to the bid documents only after the following requirements are met and the proposed listed material is determined to meet or exceed the requirements:
   1. Requests for listing to be original material, clearly indicating the product fully complies with contract documents and be neatly marked with yellow felt tip marker to clearly define and describe the product for which listing is requested.
   2. Include certified laboratory test report for lighting fixtures.
   3. Samples shall be submitted if requested.
   4. Requests shall be received 10 days prior to bid opening.
   5. Requests containing insufficient information to confirm compliance with contract documents will not be considered.

C. After Award of Contract: Substitution of products will be considered after award of contract only under the following conditions:
   1. The Contractor shall have placed orders for specified materials promptly after contract is awarded and the specified products cannot be delivered to the project to meet the Owner's construction schedule.
   2. The reason for the unavailability is beyond the Contractor's control, i.e., due to strikes, bankruptcy, discontinuance of manufacturer, acts of God.
   3. The specified product is no longer manufactured.
   4. There is compelling economic advantage to the Owner.

   In all cases, should a substituted material result in requiring electrical system or building modifications; the Contractor alone shall pay all costs to provide these modifications including all costs to the Engineer and Architect for redesign, and updating of record drawings required to accommodate the required modifications.

PART 3 EXECUTION

3.1 CUTTING BUILDING CONSTRUCTION

A. Obtain permission from the Architect and coordinate with other trades prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills or concrete saws except where space limitations prevent the use of such tools.

B. All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that particular building trade.

3.2 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire rated floor and wall assemblies to maintain fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 section "Firestopping".

3.3 PAINTING

A. Items furnished under this Division that are scratched or marred in shipment or installation shall be refinished with touchup paint selected to match installed equipment finish.

3.4 CLEAN UP

A. Contractor shall continually remove debris, cuttings, crates, cartons, etc., created by his work. Such clean up shall be done daily and at sufficient frequency to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation, Contractor shall carefully clean cabinets, racks,panels, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.

1. Wipe surfaces of all communications and low voltage equipment and cabling. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

3.5 TESTING AND DEMONSTRATION

Demonstrate that all communications and low voltage equipment operates as specified and in accordance with manufacturer's instructions. Perform tests in the presence of the Architect, Owner or Engineer. Provide all instruments, manufacturer's operating instructions and personnel required to conduct the tests. Repair or replace any electrical equipment that fails to operate as specified and or in accordance with manufacturer's requirements.

END OF SECTION

HANGERS AND SUPPORTS FOR COMMUNICATIONS 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.

1.2 SUMMARY

A. Section includes discrete J-Hooks, slings and related accessories for supporting low voltage cable bundles above accessible ceilings and below accessible raised floor systems.

1.3 REFERENCES

A. American National Standards Institute (ANSI)/ Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
   1. ANSI/TIA/EIA 568-B.1 Commercial Building Telecommunications Cabling Standard
   2. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces
   3. ANSI/NFPA 70 National Electrical Code

B. Underwriter's 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

1.4 DEFINITIONS

UTP	Unshielded twisted pair
Pathway	A series of supports and accessories for placement of low voltage systems cables
Main Pathway cables	A low voltage systems pathway where the cable count exceeds 30

1.5 SUBMITTALS

A. Provide submittal information in accordance with Section 270500 - 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. Shop Drawings: For projects where the low voltage systems cable pathways are not shown on the drawings, they are to be contractor designed per Part 3. The contractor shall prepare and submit proposed main pathway layout drawings for review and approval by the Owner's representative prior to installing supports. Shop drawings shall:
   1. Indicate pathways on plan view
   2. Include elevations and sections to indicate space allocations and coordination with work of other trades
   3. Include details to describe the different support configurations, accessories, attaching means and cable groupings

D. Closeout Submittals
   1. Provide complete copy of approved submittal documentation with the OandM Manuals.
   2. As-built Drawings: Provide marked up as-built drawings of main pathways

1.6 QUALI TY ASSURANCE

A. Low voltage system cable supports and accessories shall be listed to Underwriter's 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. Contractor shall organize meeting a minimum of 30

days prior to initiating cable support installation work. Attendees shall include contractor, appropriate subcontractors, low voltage system vendors, architect and engineer. 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.

1.7 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 Engineer.

B. Examine drawings and existing conditions above ceilings and include additional supports in bid price to avoid ducts, pipes, conduits, etc. Installation in existing ceilings if very difficult. Include extra labor time involved in bid price.

PART 2 PRODUCTS

2.1 WIDE BASE CABLE SUPPORTS

A. J hooks complying with EIA/TIA 568-B.1 and 569-A structured cabling system requirements. Minimum size is 1-5/16 inch diameter loop for (50) 4-pair UTP or 2 strand fiber optic cable or inner duct. Provide larger size or multiple hooks where required. Minimum 1" width and flared edges where cables enter and leave support. 2 inch diameter loop for (80) 4-pair UTP or 2 strand fiber optic cable or inner duct. 4 inch diameter loop for (300) 4-pair UTP or 2 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
3. Or approved equivalent.

PART 3 EXECUTION

3.1 INSTALLATION

A. All low voltage systems cables shall be supported. Provide supports along entire Pathway.

B. Space supports a maximum of 48 inches apart and at each change of direction of the cables.

C. 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.

D. 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.

E. Where specific main pathways are not indicated on the drawings, the cable pathways for all low voltage systems shall be designed by the contractor. The contractor shall coordinate pathways with all other trades to achieve efficient utilization of available space, complete accessibility to allow maintenance of cable plant and economical future adds moves and changes. Contractor shall provide Main pathway shop drawings for review and approval by the Owner's representative

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. Group cabling in separate supports by the following systems:
Voice and Data Cabling
CCTV/CATV/Video Systems/ Radio and Satellite Systems
Audio
Building Automation, Lighting Control Systems
When total cable count to a small group of work stations or offices is less than 24, the cables may be installed grouped in a single support of appropriate size.

J. Interface with Other Work: Coordinate installation of supports with mechanical ductwork, piping and sprinkler system piping so that supports remain accessible after installation.

K. Install low voltage cable support system above accessible ceilings and below accessible raised floor systems only.

L. Elevation of Cable Supports: Contractor shall coordinate the allocation of ceiling space and the mounting elevations of various systems to allow maintenance and accessibility for future modifications. Low voltage system 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.

M. Cable installation and supports shall comply with applicable provisions of EIA/TIA 569-A and ANSI/NFPA 70.

END OF SECTION

CONDUITS AND BACKBOXES FOR COMMUNICATIONS 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. Related Sections
1. Section 260533 - Raceways and Boxes for Electrical Systems

C. Other References

EIA/TIA-569A	Commercial Building Standard for Telecommunications Pathways and Spaces
TIA/EIA/ANSI-J-STD-607-A	Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

1.2 DESCRIPTION

A. Provide raceway systems for the installation of the telephone cables and computer wiring. Installation shall include raceways, outlet boxes, plaster rings, outlet box cover plates and terminal back boards.

PART 2 PRODUCTS

2.1 WALL OUTLETS

A. Shall consist of a 4-11/16" square, 2-1/8" deep (minimum) box, with knockouts for 3/4", 1", and 1-1/4" conduits, as manufactured by Steel City, OZ/Gedney or equal.

B. Surface wall outlets shall be 4" square, 2-3/4" deep (minimum) and shall match and be manufactured by the surface metal raceway manufacturer.

2.2 FLOOR OUTLETS

A. See Section 260533.10 - Flush Floor Outlets for flush floor outlets.

B. See Section 260533.20 - Floor Outlet Devices Poke Thru for poke-thru floor outlets.

2.3 OUTLET DEVICE RING

A. Provide single gang device ring.

B. Coordinate device ring requirements with cable/outlet installer

2.4 DEVICE PLATES

A. Provide device cover plates for all unwired or "future" outlets. Plates shall match device plates specified in Section 262726 - Wiring Devices except with no device openings.

2.5 PULL WIRE

A. Shall be plastic having not less than 200-pound tensile strength.

2.6 TELEPHONE TERMINAL BOARDS

A. Shall be 3/4 inch plywood backboard 8' feet high by 4" wide or as indicated in plans. APA interior grade Douglas Fir A-C. Shall be fire retardant with flame spread rating not more than 25 when tested according to ASTM E84.

2.7 TELECOM GROUND BAR, TELECOM MASTER GROUND BAR (TGB, TMGB)

A. Copper bus bar, 10 x 4 x 1/4" with a minimum of six (6) 3/8-inch and four (4) 1/2-inch diameter holes on 2-inch centers with screw lugs to secure ground wire terminations. Suggested Product: Universal Bus Bar #10622-010 or similar by Everett Machine Works or as detailed on the drawings. Mount with 4-inch insulated stand-off brackets.

PART 3 EXECUTION

3.1 WALL OUTLETS IN UNINSULATED INTERIOR WALLS WITH ACCESSABLE CEILINGS

A. Provide an individual conduit from each communications outlet to an accessible location at cable tray or to a telephone terminal backboard.

3.2 WALL OUTLETS IN UNINSULATED INTERIOR WALLS WITH NON-ACCESIBLE CEILINGS, EXTERIOR WALLS OR INSULATED INTERIOR WALLS

A. Provide an individual conduit from each communications outlet to an accessible location at cable tray or to a telephone terminal backboard.

3.3 FLOOR MOUNTED OUTLETS

A. All conduits from floor outlets shall terminate in a space on the same floor as the outlet.

B. Provide an individual conduit from each communications outlet to an accessible location at cable tray or to a telephone terminal backboard.

3.4 SURFACE METAL RACEWAY CONNECTIONS

A. Provide an individual conduit from each surface raceway to an accessible ceiling space.

B. Provide an individual conduit from each surface raceway at cable tray or to a telephone terminal backboard.

3.5 CONDUIT SIZING TABLE

A. Provide conduits for communications outlets sized as follows:

Wall Phones	3/4”
Wall Outlets (except wall phones)	1"
Single Gang Floor Mounted Outlets/Boxes	1"
Multiple Gang Recessed Floor Outlets/Boxes	1-1/4"
System Furniture - per every (2) workstations	1"
System Furniture - per every (3) workstations	1-1/4"
Surface Metal Raceway - per 12 ft of SMR	1"
Surface Metal Raceway - per 20 ft of SMR	1-1/4"

3.6 RACEWAYS

A. Shall conform to specification Section 260533 - Raceways and Boxes for Electrical Systems with the additional requirement that 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.

B. 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.

C. Provide an insulated bushing on all conduits terminated in a cabinet and/ or pullboxes.

D. Terminate conduits stubbed out above accessible ceiling space so that the conduit is parallel with the ceiling and provide an insulating bushing.

E. Terminate conduit at cable trays at an accessible location within 6" of tray with an insulated bushing and provide bonding jumper or terminate conduit to the cable tray with an insulated bushing.

3.7 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

3.8 PULL CORDS

A. Nylon type shall be included in all raceways over 10 feet long. Leave not less than 12 inches of slack at each end of the pull wire.

3.9 GROUNDING

A. Provide a Telecom Master Grounding Bar in the telecommunications entrance facility

B. Provide a Telecom Grounding Bar in each telecom room.

C. Telecom Bonding Conductor and Telecom Bonding Backbone (TBB)
   1. Provide a telecom bonding conductor between the building electrical service entrance equipment ground and the telecom main ground bar (TMGB).
   2. Provide a telecom bonding backbone conductor (TBB) between the TMGB and each telecom room ground bar (TMB). Unless otherwise indicated on the Grounding Riser, the TBB conductors shall follow the configuration of the telecom backbone.

D. Panelboard Bonding: For each telecom room, provide a bonding conductor between the ground bus of each panelboard serving electrical equipment within the telecom room and the TGB serving the room.

E. Structural Steel Bonding: Provide a minimum #6 conductor from the TMGB or TGB to a readily accessible point on a vertical member or permanently electrically bonded horizontal member of the structural steel system of the building.

F. Pathway Bonding:
   1. Bond all metal pathways (conduits, cable tray, and cable runway) within telecom rooms to the TMGB or TGB, with the exception of floor and wall sleeves.

G. Telecom Grounding/Bonding Conductor Sizing:

Maximum Length	Wire Size (AWG)
4m (13ft)	6
6m (20 ft)	4
8m (26 ft)	3
10m (33 ft)	2
13m (41 ft)	1
16m (52 ft)	1/0
20m (66 ft)	2/0
Over 20m (66 ft)	3/0

H. Label each grounding and bonding conductor as follows: "IF THIS CONNECTOR OR CABLE IS LOOSE OR REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER."

I. Refer to Section 260526 - Grounding and Bonding For Electrical Systems, for additional grounding requirements.

3.10 RACEWAY RISER SLEEVES

A. Riser raceways to be installed through floors with tops 6 inches above each floor to give continuous cable riser capability. Stuff sleeves with an approved non-combustible material such as rock wool to maintain floor fire separation.

3.11 REMODEL SPACES

A. Remove in active and abandoned telephone and computer conductors that serve spaces remodeled, only after receiving approval from the owner.

B. Notify owner in writing when active telephone and computer conductors serving occupied spaces and must be relocated due to the remodel.

END OF SECTION

FIRE DETECTION AND 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.

1.2 SUMMARY

A. This Section includes fire alarm systems with manual stations, detectors, signal equipment, controls, and devices.

B. Related Sections
   1. Section 087000 - Hardware for door closures/holders, electric door locks, and release devices that interface with fire alarm system.
   2. Division 21 - Fire Suppression for waterflow, valve tamper switches and post indicator valves that interface with fire alarm system.
   3. Division 25 - Integrated Automation for interface between mechanical HVAC control system and fire alarm system.

C. Substitutions: Substitute products will be considered only under the terms and conditions of Section 280500 - Common Work Results For Electronic Safety and Security.

1.3 REFERENCES

A. American National Standards Institute (ANSI)

B. National Electrical Manufacturers Association (NEMA)

C. Underwriter's Laboratories, Inc. (UL)

D. National Fire Protection Association (NFPA)

1.4 APPLICABLE CODES AND STANDARDS

A. Provide the system in compliance with the following:
   1. NFPA Codes, Standards and Manuals (latest issue enforced)
      a. 70 - National Electrical Code
      b. 72 - National Fire Alarm Code
      c. 90A- Standard for the Installation of Air Conditioning and Ventilating Systems
   2. International Fire Code (IFC)
   3. Other Codes
      a. Local fire code, building code, mechanical code, electrical code, rules and interpretations required by the Authority Having Jurisdiction.

1.5 QUALITY ASSURANCE

A. Each and all items of the Fire Alarm System shall be listed as a product of a fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL) and Factory Mutual (FM), and shall bear the UL and FM labels. All control equipment shall be listed under UL Category UOJZ as a single control unit. Partial listing is NOT acceptable.

B. In addition to UL-UOJZ requirement mentioned above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760.

C. All control equipment shall have transient protection devices to comply with UL 864 requirements.

1.6 CONTRACTOR DESIGN

A. The contract drawings indicate the general nature of the fire alarm system, but do not necessarily show all components required. The drawings are intended to aid the Contractor and/or subcontractor and/or supplier in providing the complete fire alarm system required. Raceways, routing and wiring are not shown on the drawings and it shall be the responsibility of the fire alarm system supplier to design raceway routing and wiring and to show the same on shop drawings.

B. Evacuation alarm sound level: The number of fire alarm notification devices shall be increased if required by the AHJ.

1.7 SUBMITTALS

A. General: Make submittals in accordance with Section 280500 - Common Work Results For Electronic Safety and Security.

B. Product Data: Submittals shall include a compilation of manufacturer's catalog or specification sheets of all system components. Items being provided shall be clearly indicated. Any variations of the submittal from the specifications shall be clearly indicated. Include the following additional information:
   1. Point Schedule
   2. Complete schedule of customized English message formats of alarms and troubles for system.
   3. Battery systems and standby battery load calculations.
   4. Fire Alarm zone and address schedule including alphanumeric description for each monitor and control point.
   5. Actual graphic drawings.
   6. Outputs zone schedule for off-premise UL Central Station Monitoring.
   7. Complete sequence of operations for all fire alarm system functions.

C. Shop Drawings
   1. Riser Diagrams. Fire alarm supplier and/or subcontractor shall develop CAD based original fire alarm riser diagram to show main geographical fire alarm zones and point to point wiring requirements.
   2. Floor Plans. CADD based floor plans shall be drafted to show conduit routing, device locations, end of line resistors, wire count and color coded wiring between device locations on each plan. Show room names and numbers for each room where a fire alarm device is located.
   3. Release of CADD files for shop drawings. Contractor may request to utilize the project CAD drawing files in producing shop drawings. Request shall be made by signing Sparling's "Agreement for Release of CADD Files" letter.
   4. Ownership. All original shop drawings shall become the property of the Owner at the completion of the project.

D. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals specified in Division 1 Section "Submittals", make an identical submission to authorities having jurisdiction. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

E. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Comply with NFPA 72.

G. Certificate of Completion: Comply with NFPA 72.

H. Operation and Maintenance Manual: Per Section 280500 - Common Work Results For Electronic Safety and Security. Include record drawings, Certificate of Completion, and test results.

1.8 TECHNICAL BID PROPOSAL

A. Technical Bid Proposal: The fire alarm system supplier shall submit with his bid a technical proposal of adequate depth to fully define the system offered. Data of a business nature is not required. Manufacturer shall list references with telephone numbers for proof that he has had experience in installing fire alarm systems of this type. As a minimum, the technical proposal shall include the following:
   1. Description of the configuration and operation of the proposed system.
   2. Include catalog cut sheets or other descriptive material of major components.
   3. A complete copy of the fire alarm system specification with each subparagraph noted with the comment, "compliance," "deviation," or "alternate."
      a. By noting the term "compliance," it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
      b. By noting the term "deviation," it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
      c. By noting the term "Alternate," it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.

4. Items specifically called for in this specification are to provide for specific performance and quality of components desired and shall not restrict any manufacturer from furnishing an equivalent product for the performance an operation intended as described above.
5. Two copies of the technical proposal from the proposed fire alarm system supplier shall be submitted to the Owner at the time of or prior to the bid opening.

1.9 ADDITIONAL REQUIREMENTS

A. Fire Alarm System Supplier and/or Subcontractor Requirements:
1. Coordinate the installation of the fire alarm system including the preparation of shop drawings in conformance with Section 280500 - Common Work Results For Electronic Safety and Security.
2. Furnish and load all software required to implement a complete monitoring and control system.

B. Contractor Requirements:
1. Submit shop drawings to the "Authority Having Jurisdiction" (AHJ) as defined in NFPA 72. The AHJ for this project is the local Fire Marshal. One copy of the above shop drawings with this approval evidenced shall be included with the submittal required by Section 280500 - Common Work Results For Electronic Safety and Security.
2. Provide raceway, back boxes, wiring, and power circuits for the fire alarm system, and install the devices ready for final termination at the Fire Alarm Panel by the Fire Alarm System Subcontractor. Contact the fire alarm system subcontractor prior to bidding to determine exact requirements and include all costs in the bid price.
3. Provide all 120V power circuits to fire alarm control equipment and remote power supplies. Remote power supplies are not shown. Contact the fire alarm system subcontractor prior to bidding to determine exact 120V power requirements and include all costs in the bid price.
4. In addition, the Contractor shall schedule periodic inspections by the AHJ during the course of the installation and shall make any minor corrections, deletions, relocations or additions to the system as required for acceptance of the completed system by the AHJ. Contractor shall obtain and pay for all required permits.
5. Coordinate the interface requirements between mechanical control systems and the fire alarm system.
6. Performance Test: Final approval of the fire alarm system is contingent upon a successful performance test, accomplished by the installer and witnessed by the Fire Marshal.

1.10 DESCRIPTION

A. General: Non-coded, addressable-analog fire alarm system with manual and automatic alarm initiation; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only. Provide a complete and fully operational fire detection and alarm system which fully complies with the local fire code currently enforced at the project location. If any conflict occurs between government adopted code rules and these contract documents, the codes are to govern.
1. The existing annunciation location shall be maintained with new devices connected to the new fire alarm system.

B. Sprinkler System Monitoring
1. Coordinate the Fire Alarm System with the Sprinkler System to provide circuits for detection and annunciation as required by the AHJ to supervise PIV, OSY and gate valve positions. Provide circuits for detection and annunciation of water flow. Each water flow device and its associated valve position switch shall have their own address.
2. Provide circuits for detection and annunciation of tamper switch positions. Each tamper switch device shall have its own address and activate the system supervisory trouble light. Differentiation between valve tamper switch and open/or grounds in the initiation circuit wiring shall be provided.

C. Elevator Capture. Provide circuitry to the elevator controllers to indicate when an alarm has been initiated by the associated elevator lobby smoke detectors to initiate recall. Coordinate exact circuitry required with elevator subcontractor. Provide circuits from FACP to corresponding elevator controller.

1.11 OPERATION OF FIRE ALARM SYSTEM

A. Operation of any initiation device shall immediately cause all of the following:

1. All fire alarm speakers to sound a three pulse temporial tone pattern (per ANSI S3.41) throughout the facility until silenced by a switch at the Fire Alarm Control Panel (FACP) or until the system is reset. Visual alarm lights throughout shall flash repetitively until the system is reset.
2. Auxiliary controlled devices shall operate until the alarm condition is corrected and the system reset.
3. Full English language annunciation of the alarm condition, type and location at the FACP display. An audible signal shall sound and the alarm condition shall flash on the FACP display and CRT until acknowledged. Emergency instructions shall be displayed in English for the operator.
4. Automatically transmit a general alarm and common trouble alarm to the local Fire Department via the Owner's monitoring company.
5. Send a signal to the mechanical control system to identify the building is in alarm. All mechanical smoke controlled measures will be controlled by the mechanical control system.

B. Air handling equipment to be automatically shutdown only when activated by the smoke detector located in the supply air duct downstream of the filters. Both the supply fan and its related exhaust fan shall be shut down by the same sensor.

C. History Logging: The system shall log and store 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in random access memory with battery protection. Each event shall include the time and date of the events occurrence.

D. The system, including annunciation, and remote annunciation shall be completely supervised to sound an audible and visual trouble signal upon the occurrence of any open or grounded circuits except that auxiliary control circuits (door holders, and fan shutdown) and smoke detector remote indicator lights need not be supervised. An open or grounded zone circuit or annunciator circuit shall illuminate the trouble lamp and sound the trouble alarm at the control panel.

E. Sprinkler System Monitoring
1. Activation of a PIV, OSY, gate valve, or flow switch shall initiate the sequence of alarm operation described herein.
2. Activation of any tamper switch shall activate the system supervisory trouble light.

F. Elevator Capture. Initiation elevator capture sequence.

1.12 DEFINITIONS

A. FACP: Fire Alarm Control Panel.

B. LED: Light-emitting diode.

C. Definitions in NFPA apply to fire alarm terms used in this section.

1.13 INTERFACE REQUIREMENTS

A. The Contractor is responsible for coordinating the system with Owner furnished and other Contractor furnished systems and equipment. The work consists of but is not limited to the following:
1. Mechanical Control Panels. Division 28 automatically controls all fire/smoke dampers and Division 25 provides all fire/smoke dampers. Provide control relays with wiring as shown on the drawings.
2. Duct Smoke Detectors. Duct smoke detectors and associated sampling tubes installed by Division 25 Contractor. Provide final connections and testing of duct smoke detectors.
3. Elevators:
   a. Fire Emergency. Control module dry contact with wiring to the elevator controllers to signal a fire emergency mode for automatic elevator recall.
   b. Elevator Lobby Smoke Detectors. To signal smoke in an elevator lobby to the FACP.
   c. Elevator power shut down control circuit shall be monitored for presence of operating voltage. Loss of voltage shall cause a supervisory signal at the control panel and remote annunciators
   d. Fire Signal Speakers. Provide speakers for all elevators. Coordinate installation with Division 14.
   e. Ensure that all systems on the existing elevator are operational and per code.

1.14 RECORD DRAWINGS

A. Provide per Section 280500 - Common Work Results For Electronic Safety and Security. Record drawings shall clearly indicate:
1. Actual routing of all raceways and location of all junction boxes.

2. Actual cable types, numbers and routing.
3. Actual system wiring diagrams, connection diagrams and interface of all components in the system.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. All equipment shall be the product of a single manufacturer except that certain individual components which are regularly used as part of the system may be the product of a different manufacturer. Approved manufacturers:
   1. Simplex Time Recorder Company

2.2 TRANSIENT PROTECTION DEVICES

A. All control equipment shall have transient protection devices to comply with UL 864 requirements:
   1. Provide an Isolated Loop Circuit Protector (ILCP) device on all fire alarm initiating circuits, alarm indicating appliance circuits, signaling line circuits which extend beyond the main building by either aerial, underground or other methods, walkways, bridges or other above ground connectors.
   2. The ILCP shall be located as close as practicable to the point at which the circuits leave or enter the building.
   3. The ILCP grounding conductor is to be a No. 12 AWG wire having a maximum length of 28 feet to be run in as straight a line as practicable and connected to a building ground electrode system (unified ground) per Article 800 of the National Electrical Code.
   4. The ILCP is to have a line to line response time of less than one (1) nanosecond capable of accepting greater than 2000 amps (9 joules each line) to earth. Shield to earth current is to be 5000 amps maximum.
   5. The ILCP shall be protected by a high dielectric insulating material and of small enough size to mount in a standard 4" square 2 -1/8" deep electrical box.
   6. Spark gap devices or devices incorporated in or installed within the fire alarm control panel in lieu of the specified ILCP are not acceptable.
   7. All ILCP's shall comply with UL 497B requirements.

2.3 SECONDARY POWER SUPPLY

A. General: Components include gel cell sealed batteries, charger, and an automatic transfer switch.
   1. Battery Nominal Life Expectancy: 2 years, minimum.

B. Battery Capacity: Comply with NFPA 72.

C. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.
   1. System shall be configured to hold all magnetic door holders open for at least 60 seconds in the event of utility power failure.

2.4 MANUAL PULL STATIONS

A. Description: Fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color.
   1. Double-action mechanism requiring two actions, such as a push and a pull, to initiate an alarm.
   2. Station Reset: Key or wrench operated, rated for the voltage and current at which it operates.
   3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false alarm operation.
   4. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2.5 SMOKE DETECTORS

A. General: Include the following features:
   1. Operating Voltage: 24-V dc, nominal.
   2. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation except resetting the control panel.

3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
4. Integral Visual-Indicating Light: LED type to indicate when detector has operated.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
7. Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. All smoke detectors located adjacent to roll down smoke doors or motorized smoke doors shall be provided with a relay base.

B. Photoelectric Smoke Detectors: Include the following features:
1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detector: Photoelectric type.
1. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
2. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 OTHER DETECTORS

A. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate of rise of temperature that exceeds 15 deg F (8.3 deg C) per minute, unless otherwise indicated.
1. Mounting: Plug-in base, interchangeable with smoke detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.7 NOTIFICATION APPLIANCES

A. Description: Equip for mounting as indicated and have screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly and enclosure.
2. Provide Randl Industries 5" square, 2-7/8" deep outlet box with plaster ring.

B. Bells: Electric-vibrating, 24-V dc, under-dome type; with provision for housing the operating mechanism behind the bell. When operating, bells provide a sound-pressure level of 94 dB, measured 10 feet from the bell. 10-inch size, unless otherwise indicated. Bells are weatherproof where indicated.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns produce a sound-pressure level of 96 dB, measured 10 feet from the horn.

D. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear lens. The word "FIRE" is engraved in minimum 1-inch-high letters. Flash rate shall not exceed two flashes per second nor be less than one flash per second. Maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40 percent. Shall be suitable for installation in a single gang outlet box. Color of housing shall be white in finished areas such as offices and corridors, red housing in unfinished areas such as garage and mechanical areas.
1. Strobe Leads: Factory connected to screw terminals.
2. Combination visual/audible notification devices are allowed.

E. Voice/Tone Speakers:
1. High-Range Units: Rated 2 to 15 W.
2. Mounting: Flush, semirecessed, surface, or surface-mounted; bidirectional as indicated.
3. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
4. Speakers shall be UL listed for emergency alarm systems.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.

2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.9 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Description: LED indicating light near each smoke detector that may not be readily visible when standing in the room. Light is connected to flash when the associated device is in an alarm or trouble mode. The lamp is flush mounted in a single gang plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector.

2.10 MONITOR MODULE

A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts and for heat detectors located in high ambient temperature areas.

2.11 CONTROL RELAY MODULE

A. Description: Microelectronic control module listed for use in controlling smoke/fire dampers, door release service and other control functions.

2.12 FIRE ALARM TERMINAL CABINETS

A. Provide new as required for system reconfiguration.

B. NEMA Type 1 enclosure, hinged door front with flush hinge, latch and lock. Provide terminal blocks in all cabinets with 25% spare capacity. Box and front shall be steel, painted red with label "Fire Alarm". Flush mounted.

2.13 WIRE

A. Non-Power-Limited Circuits: Conductors shall be 600-V rated, 75 deg C, color-coded insulation.
1. Low-Voltage Circuits: No. 16 AWG, minimum, stranded copper (maximum of seven strands).
2. Line-Voltage Circuits: No. 12 AWG, minimum, solid or stranded copper.

B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

2.14 RACEWAYS, OUTLETS AND JUNCTION BOXES

A. Shall conform to specification sections "Raceways" and "Outlet and Junction Boxes".

PART 3 EXECUTION

3.1 SYSTEM SUPPLIER AND/OR SUBCONTRACTOR REQUIREMENTS

A. Determine the complete system raceway, wiring and outlet box requirements.

B. Provide and/or supervise all wiring, wiring terminations and connections.

C. Provide and/or supervise all equipment installation.

D. Perform and/or supervise all testing during and after installation.

E. Certify in writing to the Architect at completion stating that system has been inspected, tested and is complete and fully operational in accordance with contract documents.

F. Instruct and/or assist the Contractor in instructing Owner's personnel in the operation and maintenance of the system.

3.2 EQUIPMENT INSTALLATION

A. Manual Pull Stations: Mount semiflush in recessed back boxes.

B. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.

C. Ceiling-Mounted Smoke Detectors: Not less than 4 inches from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet apart in any direction.

D. Wall-Mounted Smoke Detectors: At least 4 inches, but not more than 12 inches, below the ceiling.

E. Smoke Detectors near Air Registers: Install no closer than 3 feet.

F. Duct Smoke Detectors: Comply with manufacturer's written instructions. Duct smoke detector and sampling tubes installation by Division 25 Contractor.
   1. Duct smoke detector shall be listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   2. Sampling tubes shall extend the full width of the duct.
   3. Coordinate installation with Division 25 sheet metal installer.
   4. Provide a remote indicator light when the detector is above a suspended ceiling or in an area which is not readily accessible.

G. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed.

I. Visible Alarm-Indicating Devices:
   1. Install wall mounted devices such that the lens is not less than 80 inches and not greater than 96 inches above the finished floor.
   2. Ceiling mount devices allowed where shown and shall be approved for ceiling application.
   3. More than two visible notification devices in the same room or adjacent space within the field of view shall flash in synchronization. Synchronization of devices not in the same field of view is allowed. In corridors where there are more than two devices in any field of view, they shall be spaced a minimum of 55' apart or they shall flash in synchronization.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor when the device is not visible when standing in the room.

K. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

L. Annunciator: Install with the top of the panel not more than 72 inches (1830 mm) above the finished floor.

M. Digital Alarm Communicator Transmitter: Relocate the existing communicator.

3.3 WIRING INSTALLATION

A. Provide all wiring complete per system requirements. Wiring shall be contained in steel raceways and red color junction boxes when required by code. Seal raceways to prevent air passage at each smoke detector. Permanent wire markers shall be affixed to all conductors at terminations and splices. Numbering system shall be consistent with shop drawings. All terminations shall be TandB "Sta-Kon" (or equivalent) self insulated, flanged or forked tongue lugs where connected at screw type terminals.

B. Wiring within Enclosures: Wiring in main control cabinet shall be neatly arranged and bundled with tie wraps. Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

E. Provide 1/2" raceway and wiring from the control panel to the main telephone terminal board as required for alarm transmission to the monitoring company.

F. Provide 1/2", 3 #12 from control panel to 20 amp C.B.s with lock-on device in a 120 volt panelboard. Panelboard on emergency distribution system when applicable.

3.4 IDENTIFICATION

A. Paint power-supply disconnect switch red and label "FIRE ALARM." When the fire alarm system primary power is served from a branch circuit panelboard the panel cover shall be labeled "FIRE ALARM PRIMARY SOURCE" and the branch circuit breakers serving the fire alarm system provided with "lock-on" devices.

3.5 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Section 260526 - Grounding and Bonding For Electrical Systems.

D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.6 ACCESS DOORS

A. Provide where required for access to system components. Access doors are not shown on the drawings.

B. Provide door, mounting frame and trim for access openings in ceiling. Door shall have fire rating equivalent to that of the ceiling it is installed in. Nominal door opening shall be 24" x 24" with hinge fully concealed. Latches shall be flush screwdriver operated type. In latched position, door shall seat firmly against frame at all points and there shall be no warps, sags or open gaps.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.

B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.

D. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
   1. Verify the absence of unwanted voltages between circuit conductors and ground.
   2. Test all conductors for short circuits using an insulation-testing device.
   3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.
   4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
   5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
   6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.

7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of tests.

H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.8 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours' training.
2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.10 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

3.11 OPERATION AND MAINTENANCE MANUALS

A. Provide all information as required by Section 280500 - Common Work Results For Electronic Safety and Security.

B. Include record drawings, letter of certification and record drawings.

END OF SECTION

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Removing above- and below-grade site improvements.
   2. Disconnecting and capping or sealing site utilities.
   3. Temporary erosion and sedimentation control measures.

1.2 MATERIAL OWNERSHIP

A. Except for materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site and disposed of properly.

B. Historic items, relics, and other items of interest or value to the Owner encountered during site clearing shall remain the Owner's property. Carefully remove and salvage in a manner to prevent damage and deliver promptly to Owner.

1.3 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations unless previous permission and permits are obtained.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify utility locator service for area where Project is located a minimum of 72 hours prior to site clearing.

D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until according to requirements of authorities having jurisdiction.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 UTILITIES

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Owner not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Owner's written permission.

3.4 CLEARING AND GRUBBING

A. Remove obstructions and vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
   1. Do not remove trees, shrubs, and other vegetation to remain.
   2. Cut minor roots and branches of trees to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
   4. Use only hand methods for grubbing within drip line of remaining trees.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, and gutters at existing full-depth joints unless indicated otherwise. Neatly saw-cut length of existing pavement to remain with vertical faces prior to removing existing pavement.

3.6 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
   1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
1. Preparing subgrades.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase and base course for asphalt paving.

1.2 DEFINITIONS

A. 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.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. 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 Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions 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 Owner, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. 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.

H. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

I. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

J. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated.

B. Site Information: Research public utility records and verify existing utility locations prior to ordering any material. Notify the Architect, Engineer, and Owner immediately if any discrepancies are found in the project survey.

C. Contractor to coordinate with Owner to obtain geotechnical report, if available. Recommendations in the geotechnical report shall govern over these specifications.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these 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.

D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve or use ODOT 1-1/2-inch – 0-inch BASE AGGREGATE.

E. Engineered Fill (Structural Fill): Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve or use ODOT 3/4-inch – 0-inch BASE AGGREGATE.

G. Drainage Course: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

H. Backfill and Fill:
   1. Satisfactory soil materials.
   2. Initial Trench Backfill: Use ODOT 3/4-inch – 0-inch base aggregate.
   3. Final Trench Backfill: Refer to Engineered Fill.

I. Separation Fabric: Woven geotextile, specifically manufactured for use 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: 200 lbf; ASTM D 4632.
   2. Tear Strength: 75 lbf; ASTM D 4533.
   3. Puncture Resistance: 90 lbf; ASTM D 4833.
   4. Water Flow Rate: 4 gpm per sq. ft.; ASTM D 4491.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, freezing temperatures or frost, and other hazards created by earthwork operations. Provide protective insulating materials as necessary.

B. Preparation of subgrade for earthwork operations including removal of vegetation, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing." during earthwork operations.

D. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

E. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

3.2 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.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 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.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 SUBGRADE INSPECTION

A. Proof-roll subgrade before filling or placing aggregate with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner, without additional compensation.

3.6 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 or utility pipe as directed by Owner.

3.7 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.

3.8 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.

3.9 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 walks and pavements, use satisfactory soil material.
   2. Under footings and foundations, use engineered fill.
   3. Under and around utility structures, use engineered fill.

3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 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.

3.11 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 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. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.12 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 Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Walks: Plus or minus 1/2-inch.
2. 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.

3.13 SUBBASE AND BASE COURSES

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. Compact subbase and 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 1557.

3.14 DRAINAGE COURSE

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.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. 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. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.16 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.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt patching.

B. Related Sections:
   1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: For each job mix proposed for the Work.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of City of Portland 2007 Standard Specifications 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 expected 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 Course: Minimum surface temperature of 60 deg F and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Conform to requirements of 00700 of the 2007 Portland Standard Specifications.

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 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:
   1. Provide mixes conforming to section 00744 of the 2002 Oregon Standard Specifications for Construction.
   2. Surface Course: Level 3, 1/2 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. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving 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.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

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. 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 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Spread mix at minimum temperature of 250 deg F.

B. 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.

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 nor 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. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Surface Course: Plus 1/4 inch, no minus.

B. 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. Surface Course: 1/8 inch.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner 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.

3.9 DISPOSAL

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. This Section includes exterior cement concrete pavement for the following:
   1. Curbs and gutters.
   2. Walkways.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.3 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
   1. Cementitious materials.
   2. Admixtures.
   3. Curing compounds.
   4. Applied finish materials.
   5. Bonding agent or epoxy adhesive.
   6. Joint fillers.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.5 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 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
   1. Portland Cement: ASTM C 150, Type II
      a. Fly Ash: ASTM C 618, Class C.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source.
   1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide 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, Type A.
   2. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
   3. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

2.3 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

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. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

2.4 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

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.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Proportion mixtures to provide normal-weight concrete with the following properties:
   1. Compressive Strength (28 Days): 3300 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
   3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

D. The concrete pavement shall have a solar reflectance index (SRI) of at least 29.

2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Furnish batch certificates for each batch discharged and used in the Work.
   1. When air 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

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and pavement area is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings 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 pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
   1. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   2. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
   1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
   2. Extend joint fillers full width and depth of joint.
   3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
   4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   6. 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.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
   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 groover 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.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from surface before placing concrete. Do not place concrete on frozen surfaces.

C. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. 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.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating joint devices.

I. Screed pavement surfaces with a straightedge and strike off.

J. 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.

K. 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.

L. 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.

M. 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. Fog-spray forms just before placing concrete.

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.

C. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4 inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.7 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.

3.8 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:
1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.
4. Joint Spacing: 1/2 inch.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will 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 5000 sq. ft. or fraction thereof of each concrete mix placed each day.
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 Owner 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 Owner.

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.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Owner, 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 from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION